LOCATION BASED CITIZEN REPORTING

A CASE STUDY OF A ROAD HAZARD REPORTING SYSTEM

By

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B.S. Computer Science (2003)
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Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of
Master of Science in Engineering and Management
At the
Massachusetts Institute of Technology
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ABSTRACT

Mobile phone ownership is approaching 90% of the population in the United State and most of developed countries. Among the developing countries, it's estimated that 1 billion mobile phone users will come on-line within a year. Mobile phones penetrated our society and daily lives, and unlike any other devices, it also exhibits some unique characteristics. A mobile phone is almost always on, always connected, and always with you. In case of more advanced phones, it even knows where you are and how you move. These conditions provided a perfect breeding ground for a new form of Citizen Reporting system, location-based citizen reporting.

A well designed and most advanced system must solve a real problem. The problem in this thesis describes the ever increasing road hazard problem in the United States, caused by our ageing road infrastructures and extreme weather patterns. This thesis proposes a citizen reporting system that is based on mobile technology and location based service to minimize the damages caused by road hazards each year.

The structure of the thesis consists of two parts. In Part 1, this thesis will first explain what a citizen reporting system is and what location based service is. The thesis will then present some details about the advantages and disadvantages of each concept. Finally, this thesis will provide some examples of location based citizen reporting systems. The purpose of Part I is to lay down the basic concepts that will be used in Part II.

Part II of the thesis will focus on presenting a solution to the problem by introducing Hazard Spy, a road hazard reporting system. Part II will be presented from the prospective of an entrepreneur who is seeking to launch such a hazard reporting system as a viable venture. The thesis will examine both the business side and technical side of this venture and present a complete business plan as the result.

Research methods used in this thesis include literature reviews, online sources, surveys, interviews, and field observations. Many of the frameworks and methods used in this thesis were introduced in the SDM core and elective classes (both business classes and engineering classes), including System Architecture, System Project Management, Tech Strategy, Product Design and Development , Marketing Management, Finance Theory, Financial Accounting, New Enterprise, and Mobile Programming.

The conclusion of this thesis is that the critical technology components for a location-based citizen reporting system that can alleviate the road hazard problem are already exist today in the U.S. These components have enough speed, accuracy, portability and their prices are in the range of affordability. In fact, some smartphones on the market today have all of the required technology natively. However, challenges are still laying in wait for combining these technologies into a marketable product and for launching such a product into a viable venture. The proposed product and business plan in this thesis can be one possible path to success.

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Working on this thesis turns out to be a very fulfilling experience and it is an ideal conclusion of my SDM (System Design and Management) journey. As you will see from this thesis, I incorporated everything I learned at SDM program and applied the knowledge to solve a real world problem. I could not have done it without the advice and support from many people.

First, I want to thank my thesis advisor and program director, Pat Hale. He was kind enough to advise me on my thesis with a late notice, and has done a remarkable job on guiding and polishing the final product. Beside the thesis, I want to thank Pat for the support he had shown me during the entire length of my SDM program. Pat customized the program content to my career interests and particular needs, and I must say that the SDM program is one of the best experiences and best investments in I had in my life.

I would also want to thank Professor Howard Anderson (15.390 New Enterprise) and Professor Ed Barrett (21w.789 Communicating with Mobile Technology). These two classes influenced me the most in terms of writing this thesis. The 15.390 New Enterprise class helped me to think through all of the aspects of launching a business and I essentially built the first prototype of Hazard Spy in the 21w.789 Communicating with Mobile Technology class.

I also want to thank the entire staff of SDM program for their constant support throughout my study at SDM. They absolutely made SDM a big family.

Finally, I would like to thank my real family, wife Jeannette and daughter Alicia for their unparalleled support, patience, and understanding. I could not have done it or been who I am today without them.

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Part I:

Introduction to Location Based Citizen Reporting

WHAT IS CITIZEN REPORTING?

Citizen reporting is a concept of actively engaging the members of community to report and collect certain sets of data, which can then be analyzed to draw conclusions or spawn actions. The most common citizen reporting system in United States is the 911 emergency call system. Law enforcement organizations are depending on the general public to report any crime, emergencies, fire, natural disaster, or any other life threatening situations, so that they can execute certain actions and preventions. With a citizen reporting system, the average citizens become the eyes and ears for a central organization or entity. In essence, a citizen reporting system allows the citizens to voluntarily submit any information, so that the data can be pieced together and be analyzed, and the outcome of which can in turn benefit the greater community.

WHY DO WE USE IT?

Citizen reporting systems are an effective way for soliciting information from the public and are a communication gateway to the community. A citizen reporting system puts a structure in place for average citizens to voice their concerns, report emergencies, assist in research, etc. But a system wouldn't be widely used unless people see the values in it. For a citizen reporting system, following reasons are the three most common values for the users.

1) **To get help**. In most of the cases, people use a citizen reporting system to get help. This help can be in the forms of emergency response, medical assistance, or crime prevention. Oftentimes, people are calling help not for themselves, but for complete strangers who are in trouble.

2) **To complain**. The most common example of using citizen reporting system to complain is the noise complaining hotline that exists in most local municipalities. People use these types of citizen reporting system to prevent something they seen as unjust and unsafe to themselves or the community.

3) **To improve the community**. People often report something in the safety interests of the community. Calling in for a broken traffic light, a dead animal on the road, a suspicious activity happening around the neighborhood are all examples of the motivation to improve some aspects of the community.

THE BENEFITS OF THE CITIZEN REPORTING

What is the advantage of citizen reporting? Can't any organizations or government hire their own people and deploy them in the field to collect data? Wouldn't the data from trained agents be more reliable than from the average citizen? A widely used citizen reporting system has following advantages:

1) Quicker deployment: Generally, citizens can start reporting data instantaneously as long as the reporting method is somewhat familiar to the general public.
2) Greater coverage: In theory, a citizen reporting system can reach any area as long as there are people. Using agents just can't match up with this level of scalability.
3) Cost effective: In most cases, people are willing to report anything without asking for compensation as long as they can see the value in doing it.
4) Community policing: The added-benefit of citizen reporting system is that it empowers citizens to speak up and puts a sense of duty and responsibility in the hands of citizens.

TYPES OF CITIZEN REPORTING

There are many types of citizen reporting that involve citizens submitting information freely for a common cause. Here are some examples:

- **Crime hotlines:** People can report sighting for a crime as it is developing or submit tips for unsolved crimes. Example: *America's Most Wanted* hotline.
- **Opinion poll:** People can use this type of citizen reporting to voice their opinion and show support of certain action. Example: MSNBC presidential election poll
- **Individual journalism:** This type of citizen reporting allows citizen to submit any events and news that may be of interest to others. Example: CNN's iReport.
- **Crisis management:** This type of citizen reporting can monitor the development of certain crisis within a region. Example: War on Gaza monitoring system.
- **Disease monitoring:** This type of citizen reporting can monitor the movement of certain diseases spreading across a region. Example: SARS tracking system in Southeast Asia.
- **Wild animal preservation:** This type of citizen reporting gives people the opportunity to report sightings of endangered species in order to better study their behavior and habitat, and in turn help their chances of survival.

METHODS OF CITIZEN REPORTING

Methods of citizen reporting vary widely. From the most traditional methods to the most advanced, examples listed below are some of the most common ones.

- Report in person. Example: stop by a police station and file a sexual assault case.
- Report by phone. Example: 911
- Report by Internet. Example: Online pothole reporting system
- Report by Short Message Service (SMS). This is the newest form of citizen reporting and it hasn't been adapted on a wide scale. An example of SMS reporting is a side-walk repair reporting tool deployed in Los Angeles.

CHALLENGES OF CITIZEN REPORTING

As one of the system principles stated: "no system is perfect". Citizen reporting systems face the challenges described below:

Data Validation

Citizen reporting is a form of crowdsourcing. According to Wikipedia, crowdsourcing is a distributed problem-solving and production model. Problems are broadcast to an unknown group of solvers in the form of an open call for solutions. [1] In general, the specific shortcoming of crowdsourcing is the reliability of data. Because of the fact that data is provided by an unknown group of people, distinguishing valid data from invalid data is a difficult task.

Large volumes of Data

Generally speaking, the more people use the citizen reporting system, the better. However, sorting through the explosive amounts of inbound data can be a daunting task. America's Most Wanted crime hotline receives 2,500 calls a week, among which usually only one will be considered a "hot" (promising) lead. [2]

[1] Daren C. Brabham. (2008). "Crowdsourcing as a Model for Problem Solving: An Introduction and Cases", Convergence: The International Journal of Research into New Media Technologies, 14(1), pp. 75-90.
[2] http://www.museum.tv/archives/etv/A/htmlA/americasmos/americasmos.htm

Marketing to citizen

In order for citizens to use a system, they must know about the existence of the system. Getting the word out to the public, compounded with the behavior change and learning curve associated with using a new system, often leads to the failure of the system. Informing people about the system takes time and effort, and can be easily getting out of hand.

Ensuring the anonymity of callers

Under many scenarios that a citizen reporting system is deployed, the caller's identity must remain anonymous. Most of the crime-related or politics-related reporting system requires anonymity. Erasing the trail of a call or a text message is not an easy task because, today, the information is digitized and passes through the hands of many parties before the data reaches the final destination. To completely hide the identity information, the transmission must be encrypted at every single node, making the problem more complex because it involves someone or something that one has no control.

WHAT IS LOCATION BASED SERVICE?

Most citizen reporting systems require location information to be associated with each report submitted in order to be meaningful. For example, a crime report without location information to indicate where the crime occurred is worthless. However, getting the accurate location information can be difficult. That's when the location based service can become helpful.

A **location-based service** (LBS) is an information and entertainment service, accessible with mobile devices through the mobile network and utilizing the ability to make use of the geographical position of the mobile device. [3] [4] [5]

LBS services can be used in a variety of contexts, such as health, work, personal life, etc. [6]. LBS services include services to identify a location of a person or object, such as discovering the nearest banking cash machine or the whereabouts of a friend or employee. LBS can include parcel tracking and vehicle tracking services. LBS can include mobile commerce when taking the form of coupons or advertising directed at customers based on their current location. They include personalized weather services and even location-based games. [7]

[3] "Foundations of Location Based Services", Stefan Steiniger, Moritz Neun and Alistair Edwardes, University of Zurich
[4] "Permanent Reference Document SE.23: Location Based Services", GSM Association
[5] "Location Based Services for Mobiles: Technologies and Standards", Shu Wang, Jungwon Min and Byung K. Yi, IEEE International Conference on Communication (ICC) 2008, Beijing, China
[6] Deuker, André (2008), "Del 11.2: Mobility and LBS", *FIDIS Deliverables* **11** (2)
[7] LBS Positioning Methods, http://www.navigationevent.com/pdf/tyntec_kunz.pdf

HOW DOES LOCATION TECHNOLOGY WORK?

Getting the accurate location information from other people is not a simple task. In some cases, people are stranded in an unfamiliar territory or region without knowing the street names or landmarks for references. Besides the most traditional way of describing your location verbally, there are a few other viable technologies that are commercially available to use, each with its limitations and advantages.

1) **Geocoding:** Geocoding is the process of finding associated geographic coordinates (often expressed as latitude and longitude) from other geographic data, such as street addresses, landmarks and well-known public locations, or zip codes (postal codes). [8] Geocoding can be very accurate in a well-developed urban setting, where every street address is marked. But the limitation of Geocoding is that it still requires users to know the address or landmarks.

2) **Cell ID, aka Cell of Origin (COO):** COO is a mobile positioning technique for finding a caller's cell tower (the basic geographical coverage unit of a cellular telephone system) location. COO positioning considers the location of the base station to be the location of the caller. This is not very accurate, as the majority of mobile network cells are projected from an antenna with a spread of 120° (i.e. three mounted on a mast to give complete coverage) giving a signal coverage area with the base station at one corner, rather than the centre. [9]

3) **Triangulation or "enhanced" COO:** In a GSM system, phones are consistently scanning the closest 6 base stations and lock on to the one with the strongest signal. With the data about signal strength, a program can estimate how far a user is away from each cell tower. If the location for each of these 6 cell towers is known (all mobile carriers generate 'splash maps' predicting signal coverage when planning and managing their networks), then the program can pin down the actual location of a user with a simple distance calculation to multiple know points.

4) **Wifi ID:** Another way of providing location information from a fixed communication point is by mapping Wifi IDs. Each Wifi Access Points has a SSID and when a SSID is mapped to a coordinates for the first time, its location data is kept in a database and can be matched later to provide accurate locations to other users when their phones scan the same SSID. The limitation of Wifi ID mapping is that currently not many Wifi ID's are mapped and not many mobile phones have built-in Wifi capability.

5) **GPS:** GPS is by far the most accurate method of locating a user. It uses a constellation of between 24 and 32 medium Earth orbit satellites that transmit precise radiowave signals, which allow GPS receivers to determine their current location, the time, and their velocity. In an outdoor environment with a clear view of the GPS satellites, a GPS receiver will have only between 2 and

[8] A Geocoding Best Practices Guide - Technical document describing the geocoding process and offering recommendations from the North American Association of Central Cancer Registries (NAACCR)

[9] Cellular Communications, Aug 14 2007, International Engineering Consortium On-line Education

3 meters (6 to 10 ft) of ambiguity. [10] However, the shortcomings of GPS are 1) it doesn't work indoors and 2) not many phones have a GPS unit built-in.

WHAT IS LOCATION BASED CITIZEN REPORTING?

With the understanding of what citizen reporting system is and what location based service is, location based citizen reporting is just the combination of the two. Location based citizen reporting simply is a system that tags the location information to every report filed by citizens. The location information is kept on file and can help visually displaying all of the events on an electronic map.

Examples of location based citizen reporting systems

Ushahidi

The Ushahidi citizen reporting system is a platform that allows anyone to gather distributed data via SMS, email or web and visualize it on a map or timeline. [11] Ushahidi's system was used to report violence in Kenya after the post-election fallout at the beginning of 2008. The Ushahidi Engine is being created to use the lessons learned from Kenya to create a platform that allows anyone around the world to set up their own way to gather reports by mobile phone, email and the web - and map them. It is being built so that it can grow with the changing environment on the web, and to work with other websites and online tools. Al Jazeera uses Ushahidi in their "War on Gaza" website covering the activity happening in Gaza in January 2009. [12] See figure 1 for the interface of War on Gaza application.

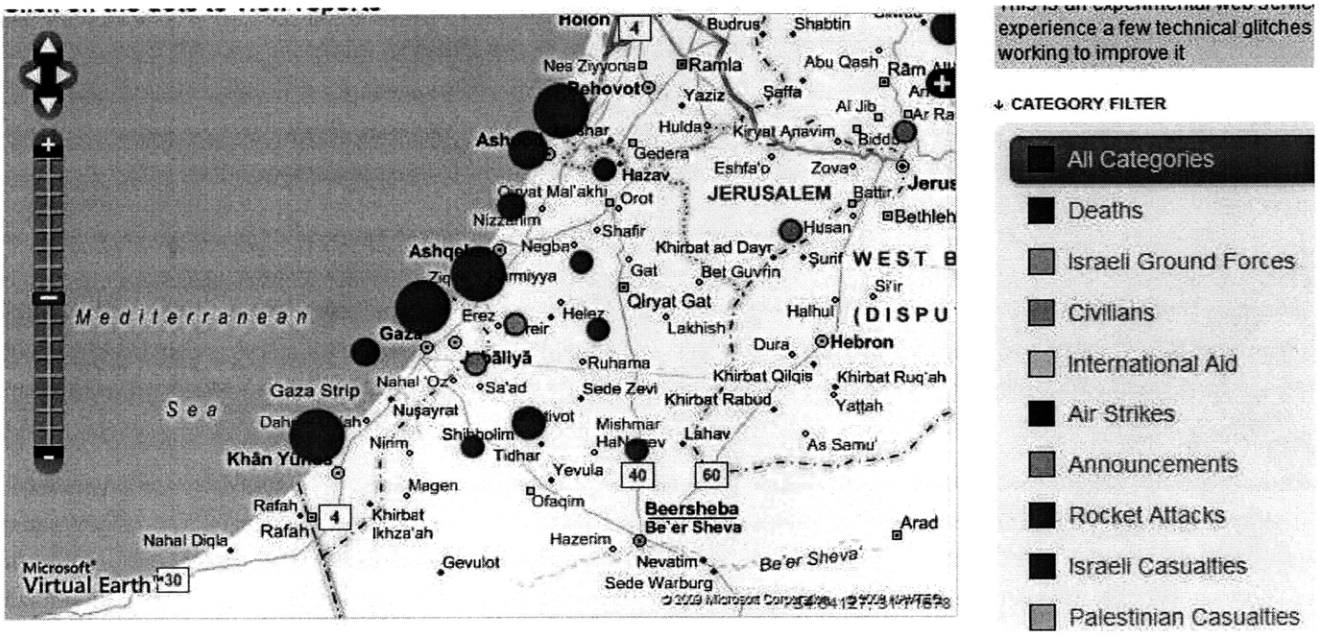

FIGURE 1: USHAHIDI APPLICATION DEPLOYED IN GAZA

[10] "United States Updates Global Positioning System Technology", February 3, 2006, America.gov
[11] http://www.ushahidi.com/
[12] http://www.ushahidi.com/work

Whooz

WHOOZ is actively engaged in mapping animal populations in Manhattan, and anyone with a cell phone can participate in mapping. The Manhattan National Wildlife Habitat, known as *Decentral Park*, is a critical national resource that provides habitat for a diverse array of flora and fauna. These are now being studied by citizen park rangers. WHOOZ is particularly interested in BATS, INSECTS, PIGEONS, and PEOPLE. Anyone can use these four keywords to submit animal sightings to WHOOZ via SMS from their mobile phone. All citizens are empowered and are invited to participate in gathering information about the ecosystems by using the Whooz System. [13] See figure 2 for a map of central park with animal sightings plotted.

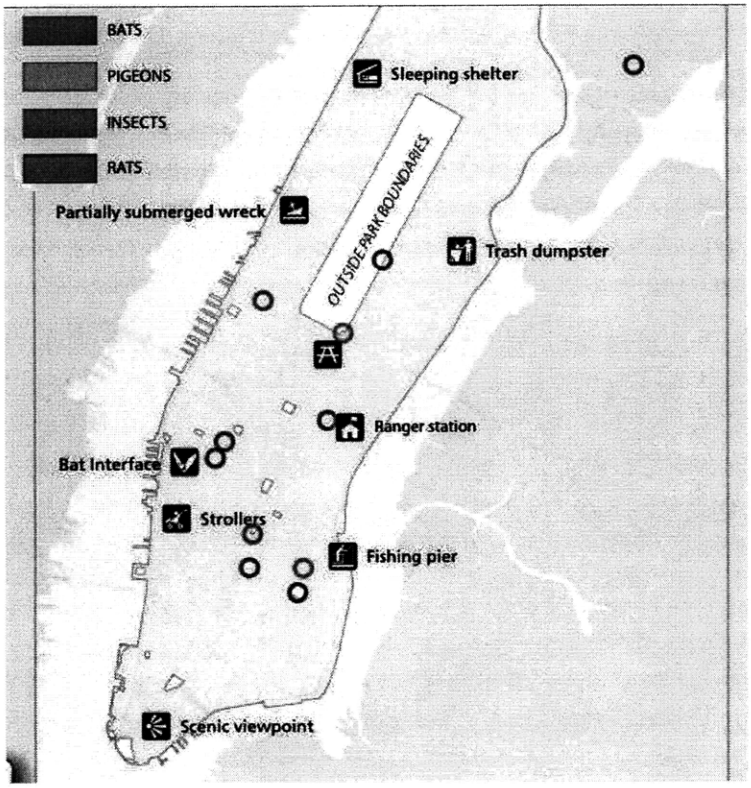

FIGURE 2: WHOOZ MAPPING APPLICATION IN CENTRAL PARK

[13] http://whooz.org/

NiJeL

NiJeL uses high performance mapping to identify and mitigate social, economic, and environmental problems in poor communities so they don't become humanitarian disasters later. These maps can be potent decision-making tools that can, among other things, help communities advocate for better living conditions. [14]

One of the projects completed by NiJel is for Beatitudes Center DOAR, which is a Phoenix-based non-profit, interfaith organization that serves home-bound elders and their caregivers, adults with disabilities, grandparents raising grandchildren, and faith communities promoting health and well-being. NiJeL worked with Beatitudes Center DOAR to create an online mapping application that shows in real-time the locations of homebound elders who need volunteer assistance. These maps can make it easier for current and potential volunteers with Beatitudes Center DOAR to see who exactly in their neighborhood needs help right now, and to facilitate matching volunteers with home-bound elders who need assistance. [15] See figure 3 for a screenshot of the DOAR map.

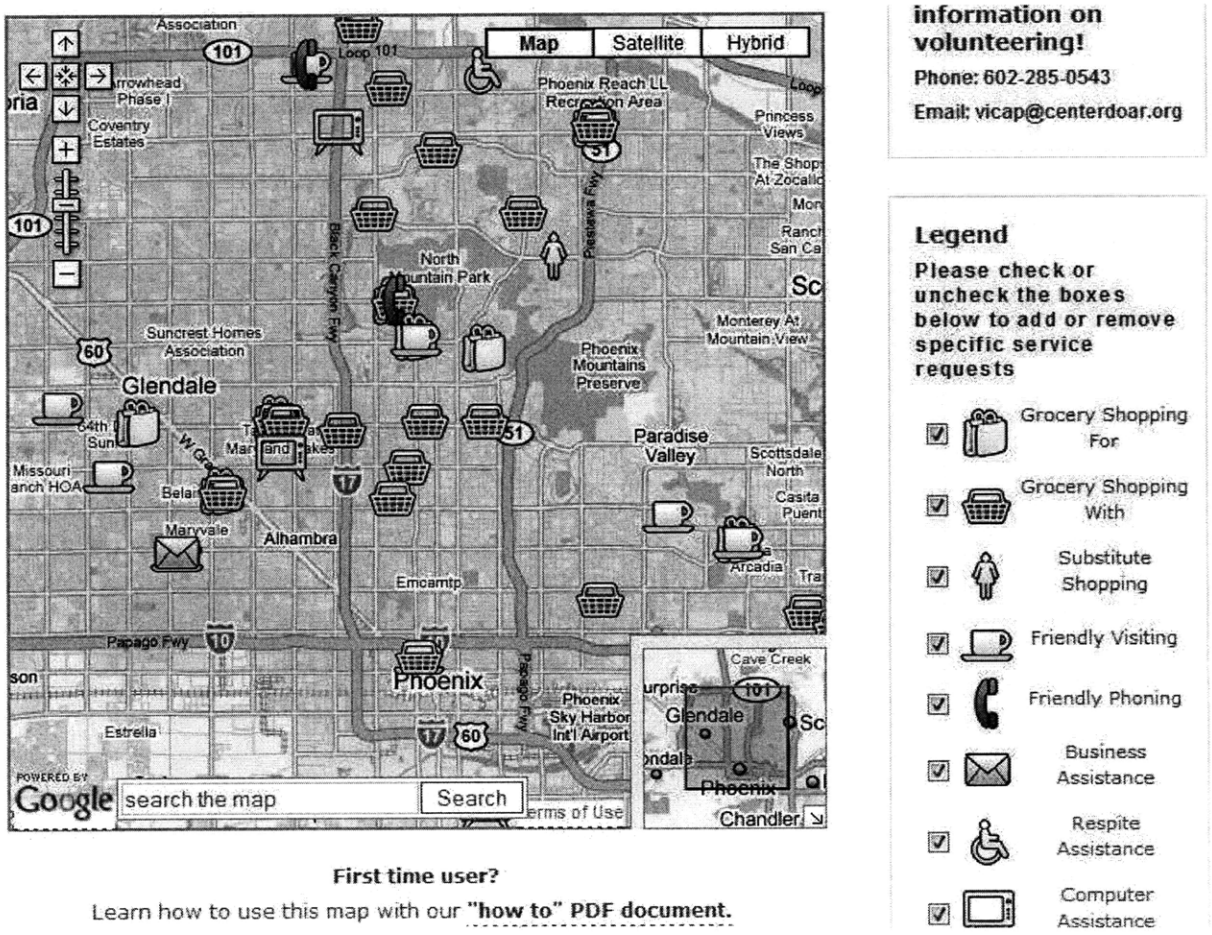

FIGURE 3: DOAR MAP PRODUCED BY NIJEL

[14] http://nijel.org/
[15] http://nijel.org/hpm.html

InSTEDD GeoChat

InSTEDD's GeoChat is a different kind of location based citizen reporting tool than those mentioned above. Instead of plotting the reported events on a map, GeoChat puts the actual people who are reporting on the map, along with their messages.

In InSTEDD's own words: "When a major humanitarian crisis occurs, every second matters for the affected community. People may be trapped, injured, or sick, and the longer it takes responders to reach them, the poorer the outcome is likely to be. What is needed is a response that is agile, efficient, and effective, where diverse groups – NGOs, the UN, national governments, military, and the local community – self-organize temporarily into a coherent, coordinated whole to provide assistance to a population in need. GeoChat is a flexible open source group communications technology that lets team members interact to maintain shared geospatial awareness of who is doing what where -- over any device, on any platform, over any network. GeoChat allows you and your team to stay in touch one another in a variety of ways: over SMS, over email, and on the surface of a map in a web browser. Whether you are sitting at a computer with a high-speed Internet connection, or on the go with your mobile phone, GeoChat let you react to events on the ground with maximum agility, forming cross-organizational virtual teams on the fly, linking field to headquarters, and keeping everyone on your team connected, in sync, and aware of who is doing what, and where." [16] See figure 4 for a sample screen capture of InSTEDD GeoChat.

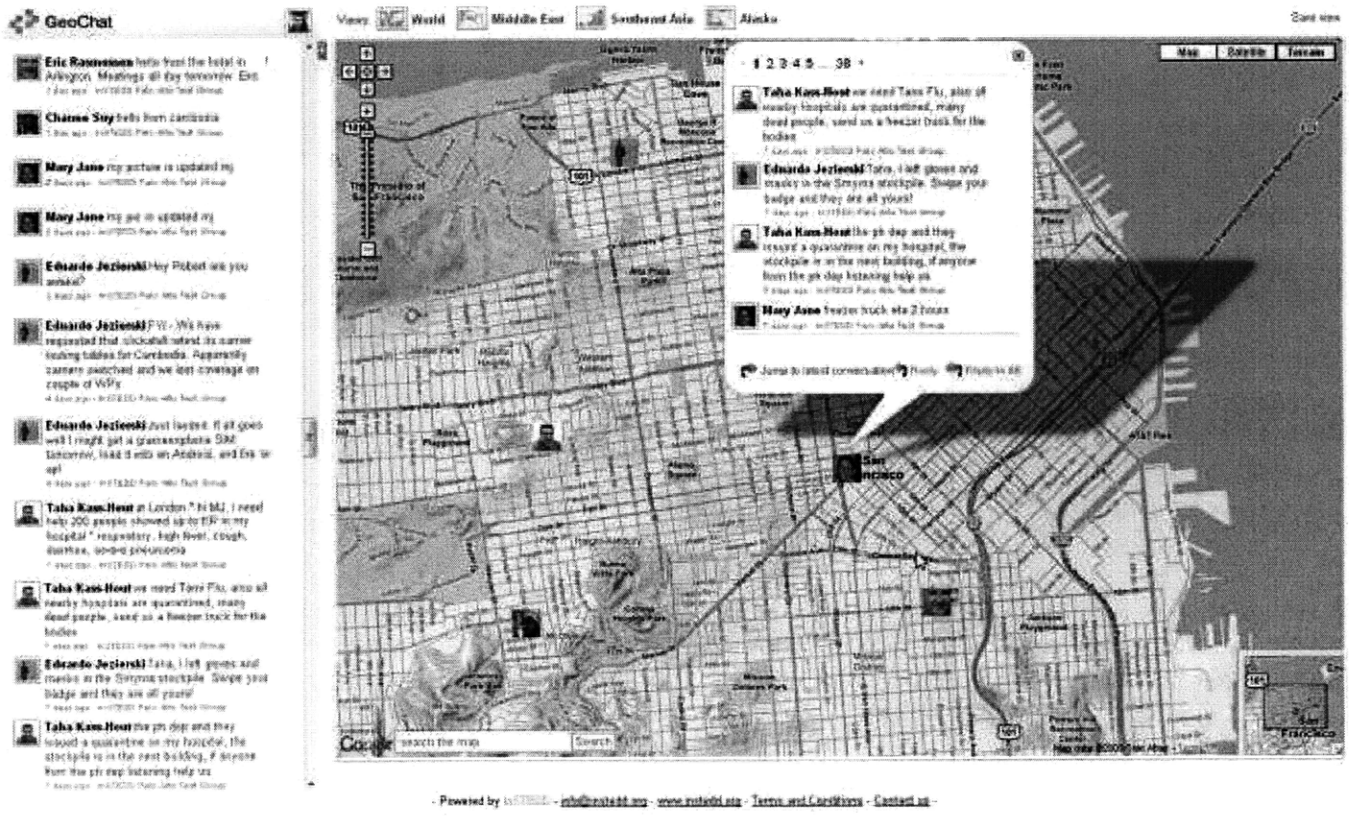

FIGURE 4: INSTEDD GEOCHAT MAP

[16] http://instedd.org/geochat

Part II

Launching Hazard Spy, a location based citizen reporting system for road hazards

Abstract

The part II of this thesis focuses on a specific category of citizen reporting – road hazard reporting. What are considered road hazards? They are potholes, debris, dead animals, high waters, car accidents, or any object that obstructs public's safety on the road.

According to US Department of Transportation, every year, more than $38 billion in financial losses are attributed to road hazard related accidents and cleanups in United States. The cause of the problem is two-fold. First, the existing hazard reporting system is inaccurate and inconvenient to use. Second, there is no system that tracks hazards in real-time, therefore, it's impossible to alert drivers about the danger.

The Part II of this thesis is a plan for launching a location based mobile application that would enable citizens to easily engage in road hazard reporting and to receive hazard information in real-time so that some accidents can be avoided. The application, Hazard Spy, can solve both of aforementioned problems. It allows drivers to send hazard location and with pin-point GPS accuracy from their mobile phones, by using either a one-touch interface or a hands-off interface. For advanced Smartphone users, Hazard Spy can even detect motions and report location information automatically, without any manual inputs. In essence, Hazard Spy aims to build a hazard map with accurate location information by utilizing the crowd sourcing concept.

The following sections introduce Hazard Spy from the perspective of an entrepreneur who is going to launch such a venture.

Hazard Spy

A LOCATION BASED ROAD HAZARD REPORTING SYSTEM

Hazard Spy is a road hazard reporting system that utilizes the citizen reporting concept and location based service concept mentioned in part I of this thesis.

MOTIVATION

The condition of road infrastructure in the United State is deteriorating. The I-35 Mississippi River Bridge collapse in Minnesota was one of the most unforgettable and devastating examples of our aging road system in the U.S. At the city and township level, potholes and hazardous road surfaces have dominated headline news lately. The city of Denver forecasts tens of millions worth of dollars spending on fixing potholes this year. [17] The winter of 2008 led to the development of serious potholes in New England as well, including one monster in Jamaica Plain that recently ravaged nine cars in rapid succession. [18]

MARKET OPPORTUNITY

According to US Department of Transportation, there were over 500,000 traffic accidents that were caused by road hazards in 2005, resulting in $38 billion in financial losses. According to TRIP, a national transportation research group:

- 33 percent of the nation's major roads are in "poor or mediocre condition."
- 36 percent of major urban highways are congested.
- 26 percent of bridges are "structurally deficient or functionally obsolete."
- Over 2,000 bridges on the interstate highway system are in need of an overhaul, according to Frank Moretti, TRIP's director of research. [19]

Although completely preventing potholes and other road hazards from forming is impossible, reducing the number of traffic accidents and deaths caused by road hazards is a realistic goal.

[17] Potholes rack up big cost, Daniel J. Chacon, The Rocky Mountain News, Feb 15, 2009
[18] http://www.boston.com/news/local/massachusetts/specials/013009_pothole/
[19] U.S. highway system badly in need of repair, John W. Schoen, Aug 3 2007, MSNBC

THE PROBLEM

Traditionally, potholes begin cropping up on roads in Northern states during March and April when dramatic weather fluctuations cause water to freeze and thaw rapidly and literally break open sections of road. In recent years, however, the so-called "freeze-thaw" syndrome began in January, with temperatures that dipped below freezing and then rose into the 40s. The phenomenon was exacerbated by the already-deteriorating condition of some aging roads, additional moisture trapped in roadside snow banks created by plowing, and the manmade problems created when salt and de-icing materials are used to melt ice and snow to make driving safer in freezing temperatures. It solved one problem but caused more damage to the road more when melting snow froze in really cold temperatures. [20]

Pothole problem is not limited to northern states. According to Gadling Travelling New, New Orleans made to the top 10 worst pothole cities in the world. [21] In temperate climates, potholes tend to form most often during spring months when the subgrade is weak due to high moisture content. [22] If a pothole fills with water the growth may be accelerated, as the water 'washes away' loose particles of road surface as vehicles pass. Even the sunny California is unable to escape the pothole plight. According to a reported release by the transportation research group TRIP and the American Association of State Highway Transportation Officials on May 9, 2009, California has nine of the top 20 cities with the most potholes, including Santa Rosa, Antioch and Concord. [23]

It is easy to suggest that the problem is just that our roads are too old and need to be rebuilt. But rebuilding an infrastructure in this scale and magnitude takes time and money. Although the Obama Administration approved a $98 billion dollar stimulus package for improving road infrastructure, most of the money will go into modernizing national highways and its effects will take time to show. Potholes and road hazards usually do most of the damage in regional freeways and local roads. Therefore, in the short term, the key to reducing damages caused by road hazards is to execute timely road maintenances and repairs, and to provide quicker emergency responses. Patching up a pothole before it becomes too big may prevent a future auto accident when cars will inevitably do a last minute swerve in order to avoid the hole.

Timely road repairs and road assistances requires timely reporting of hazard and accident sightings. This is when Citizen Reporting comes into play. In order to do large scale and real-time road condition monitoring, citizens must be called into action. However, there are several fatal flaws with the existing hazard reporting systems that are in use across the United States.

[20] Pothole problem not easily patched, Kyla & Ken Kolker, March 05 2008, Michigan News
[21] The worst potholes in the world, Apr 29th 2009, Scott Carmichael, Gadling Travelling News
[22] "pothole definition". Dictionary.com
[23] http://www.kcbs.com/pages/4363762.php?

No easy way to report a hazard

Currently, drivers have two options when it comes to reporting a road hazard. They can 1) call a hazard hotline or 2) submit an online report.

The problems with hazard hotline are

1) In the most parts of United States, each town has a different hotline phone number (and some smaller town don't even have hazard report hotline), making it inconvenient for drivers to remember the number and make a call. See figure 5 for a hazard hotline list for Grand Rapids, Michigan area.

TO REPORT A POTHOLE

Online links
Grand Rapids
Kent County email link
Michigan Department of Transportation

TELEPHONE NUMBERS

For interstates or state highways, county and township roads:
Kent County Road Commission: 242-6950
Ottawa County Road Commission: 842-5400

For local, incorporated communities, call:
Cedar Springs 696-1330
Coopersville: 997-9731
East Grand Rapids: 940-4870
Grand Haven: 847-3493
Grand Rapids: 456-3232
Grandville: 538-1990
Holland: 928-2400
Hudsonville: 669-0200, ext 4
Kentwood: 554-0817
Lowell: 897-5929
Rockford: 866-1537
Walker: 791-6854
Wyoming: 530-7260
Village of Caledonia: 891-9384
Village of Casnovia: 675-4780
Village of Kent City: 678-7232
Village of Sand Lake: 636-8854
Village of Sparta: 887-8251
Village of Spring Lake: 842-1393

FIGURE 5: HAZARD HOTLINE FOR GRAND RAPID, MI [24]

2) Most people want to avoid a conversation with a call center operator unless in a life threatening situation.

3) People don't like the idea of talking on the phone while driving and it's not safe to do so.

[24] http://www.mlive.com/news/index.ssf/2008/03/pothole_problem_not_easily_pat.html

The second way is reporting a hazard on the web. Online systems have gained popularity as Internet access is now widespread. However, the major problem with online reporting is that most people can't submit until they have access to a computer, and by that time, they procrastinate. Even when people do submit online, oftentimes they cannot remember the exact location of their hazard encounters and therefore inaccurate location information is often submitted. As an example, the screenshot for City of Boston's online reporting system (as a part of *Mark The Potholes* campaign) is shown in figure 6.

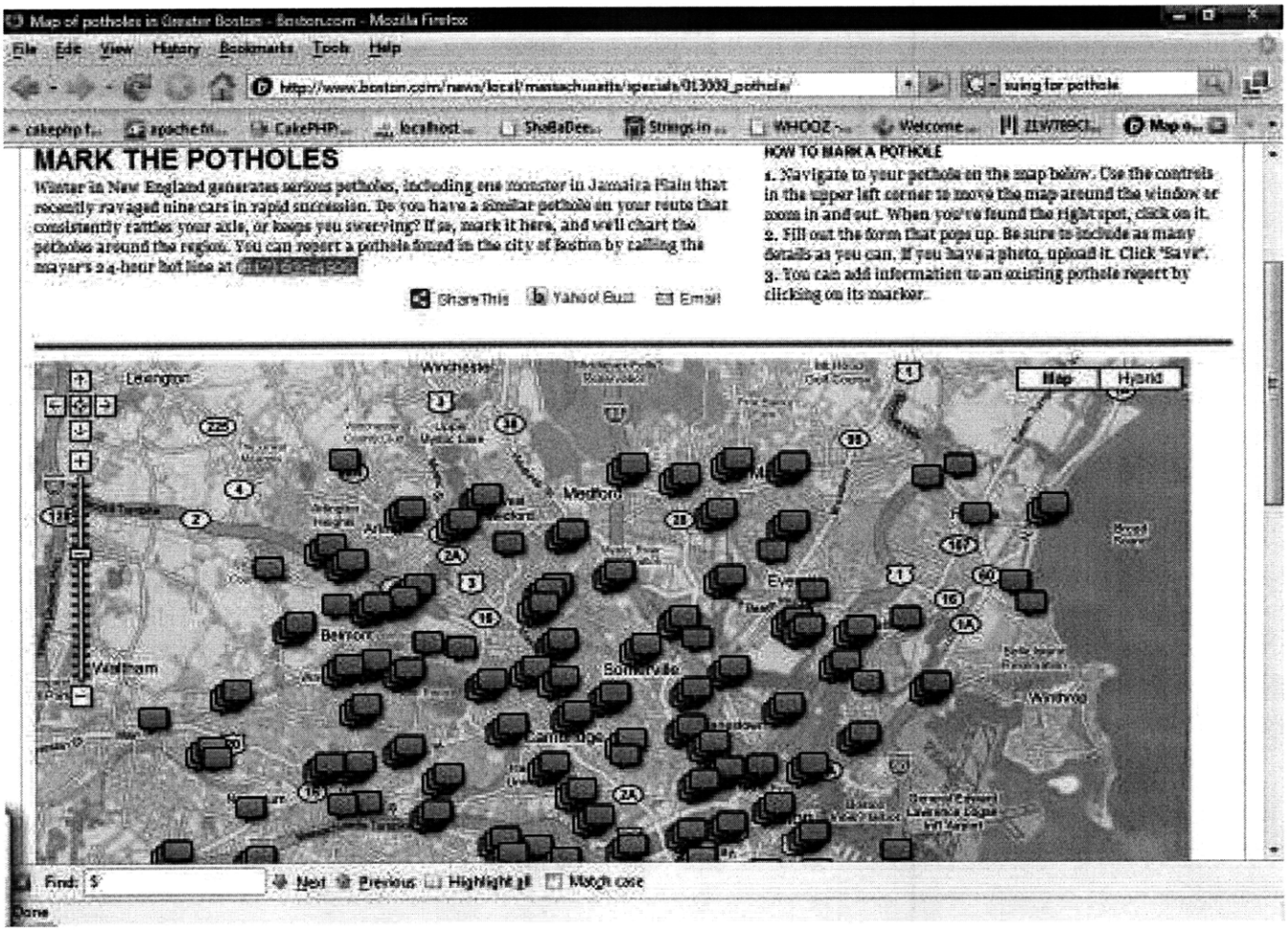

FIGURE 6: ONLINE HAZARD REPORTING SYSTEM FOR CIY OF BOSTON [25]

No easy way to validate data

Many of the local municipalities are still using the pen & paper method to track potholes. Using this method, data reported are kept in hard copies and there is simply no easy way to share the information with the public, therefore it's difficult to engage citizens for validating the data.

[25] http://www.boston.com/news/local/massachusetts/specials/013009_pothole/

An online application (such as the one used in Boston) allows anyone to put a "pin' on the map as a way to indicate a sighting of a hazard. This method puts a serious question mark on the validity of data reported. More specifically, the system has following problems:

1) The system requires no login, therefore there is no validation and no ability to identify and track false reports.

2) Often time, a user cannot remember the exact location where the encounter with a road hazard occurred, or even worse, they remember it wrong. As a result, they unintentionally marked a hazard in the incorrect position.

No easy way to visualize data

Simply plotting all the hazard sightings on a Google Map is not very user friendly to whoever is viewing the data, as all of the pins are clustered together. Notice that in figure 6, the pins are overlapping one another and it's hard to get useful information from a quick glimpse. Some of the obvious problems are:

1) No filtering of data based on the different categories of hazard (i.e. potholes, debris, dead animals, accidents, etc.)

2) No filtering of data based on the different time range when the hazard was reported. For example, if a pothole was reported three month ago, the driver should not pay as much attention to it as to those that were reported few hours ago.

3) No visual indication of the severity of each hazard. A pothole that is basketball sized should be treated differently than a pothole that is bathtub sized. However, on many of the existing systems, everything looks the same.

No warning systems about road hazard

The inefficiency in hazard reporting points to a bigger problem - no real-time warning systems in place today. Currently, no systems can track hazard locations in real-time, and therefore it is impossible to send accurate information about hazard locations to drivers, so that drivers can have some lead time to make necessary adjustments to avoid hazards. GPS companies have traffic update services which can direct cars to a different route if the traffic is jammed ahead, however, they do not have the data at individual road hazards level and lack the accurate source of location information about the hazard.

Even if there is a reliable method today to collect hazard data in near real-time and accurately, the current systems (ranging from tracking hazards on pen & paper to online tracking) all lack one critical component – the ability to push out information to end users. In another word, the information can be aggregated but cannot be easily accessed, and, therefore, it greatly reduces the benefits of collecting the data at first place.

SOLUTIONS

Develop a safe and accurate method for drivers to report hazards

Hazard Spy provides a way for drivers to report hazards while they are driving. Therefore, the information they report is real-time and their locations are accurately marked. Hazard Spy has a client application that runs independently on each driver's mobile phone. The application can report hazard information in two ways.

1) Hazard Spy uses a cell phone's built-in accelerometer to detect abnormal movements while people are driving and reports the GPS location to the server automatically. When a vehicle bumps over an object on the road or sinks into a pothole, the accelerometer determines the type of the hazard and triggers a report. Subsequently, Hazard Spy application reads the current GPS coordinates and sends the report to Hazard Spy centralized server via cellular network.

2) For phones without accelerometers, Hazard Spy provides an easy to use, one-click interface that makes reporting hazard easy for the drivers. When a road hazard is encountered, drivers will select the hazard type and click "Send" to report a hazard. The Hazard Spy application should already be launched by the driver because the benefit of using Hazard Spy to pull down real-time hazard information, and entire reporting process takes less than a second.

In either method, for those phones without GPS, Hazard Spy can connect to an external GPS unit via Bluetooth and obtain the accurate GPS coordinates of current location of the vehicle.

An important goal of Hazard Spy is to reduce user distraction in performing its functions. Drivers should focus on driving safely, rather than looking down at their mobile device to report hazards. Hazard Spy will aim at improving the safety of all drivers while limiting the safety concern of the reporting client.

Provide access to road condition data in real time

Once data from individual phones is collected, filtered, and stored, it can then be plotted on Google Maps or other mapping platforms as a way of visualizing data in Hazard Spy. Hazard Spy will provide enhanced usability with a one-glance visual clues, improved zooming and panning, and statistical tools for analyzing historical data.

Aggregated hazard data can also be pulled by individual phones from Hazard Spy central server, which will send warning messages to drivers about the dangers ahead. Depending on a driver's current location and the direction of travel, Hazard Spy will deliver messages only about the relevant hazards via a mobile phone's speaker phone. More details of these functions will be covered in the Product and Technology section of this thesis.

MARKET SURVEY

To better understand the market pain and market demands, 100 random people, from age 18 to 67, were surveyed across the United States and Canada.

Survey Method:

A 10 question survey was developed using Survey Monkey and posted on the volunteer section of Craigslist at following 11 cities: Boston, New York Metro, Chicago, Seattle, San Francisco Bay Area, Denver, Detroit, Cleveland, Atlanta, Toronto, and Vancouver. The answer choices for multiple choice questions in the survey are presented randomly, eliminating the skews from those who may have a tendency to select first choice or last choice. The survey states clearly that this is for academic purpose and no user identity will be tracked.

Survey Results:

100 people (with a large percentage from Northeast and Midwestern, two of the hardest hit region of pothole problems for winter 2008) volunteered to fill out the survey are completely strangers with 45% male and 55% female.

Some highlights of the results:

- 75% surveyed said that they had damages to their vehicle or accidents that were caused by potholes or other road hazards?
- Among those who had damage due to road hazards, 61% said they had wheel misalignment (also the No. 1 cause for failed vehicle inspection in Massachusetts) and 61% said they had punctured tires or bent rims. These are the top two types of damage caused by road hazards.
- When asked about the reasons people cannot avoid potholes, the top two choices from those who responded are 1) I saw the potholes but there were cars next to me so I couldn't change lanes and 2) There were too many of them in a stretch, so that it's impossible to dodge all of them.
- When asked whether they will report when they see a pothole or other objects on the road, 82.5% said "no", and 61.9% responded said that they don't know how to report it.
- When asked whether they will use a product that they lay on top of the vehicle dashboard and warns them about upcoming potholes or other hazards 50 - 100 feet away with 99% accuracy, 89% said that they would. Among those who said no, only one named a legitimate reason (privacy concerns). All other reasons for the "No" answer are due to the misunderstandings of the Hazard Spy product or suggestions for improving Hazard Spy for which were already planned for release. For example, they think Hazard Spy requires them to buy an extra hardware or requires modification to their vehicle. Neither is correct.

- When asked about what features and functions that they would like to see from Hazard Spy, some suggested keeping a history of all the potholes they reported on the server so that they can use it for legal law suits against the city. Others suggested to keep a track of usage data so that they can get a discount on auto insurance premiums if they have proof of consistent usages of Hazard Spy.

Overall, this survey validated that 1) Potholes causes many types of damages to people and vehicles. 2) The current hazard reporting system is not efficient. 3) People are willing to pay for an application that can help them avoid potholes. And, finally, 4) People are frustrated with the potholes and road hazards in general. One respondent was so outraged by Potholes that he wrote almost a two page essay, describing how he had to pay thousands of dollars to replace the entire underbody of the car and he sued his city twice and was determined to appeal to a higher court.

In general, the conclusion from the survey is that there is a need in market and people are willing to pay. The details of this survey can be seen in Appendix I.

POTENTIAL BENEFICIARIES

Hazard Spy essentially builds a real-time hazard map with pin-point location, which can be useful in many ways.

Urban rather than rural area

Hazard Spy will be most useful in heavy traffic urban settings, where more pothole and more accidents tend to occur. Streets in urban areas are likely to have more potholes than those in rural areas because they carry more traffic. In addition, repair work in the city may not be as timely as suburban or rural areas due to the difficulties of closing a road and routing traffics. Furthermore, during winter pothole seasons, urban areas usually have more frequent snows removals, which cause damages to road because the heavy scrapping on the road surface and accelerated cycles of melting and freezing. On the other hand, Hazard Spy may not be as effective in rural areas due to poor cellular data network coverage and a slower network speed.

Consumers

Hazard Spy's initial target audience is mainly consumers. More specifically within the consumer segment, Hazard Spy will be most valuable to motorcycle riders, luxury car owners, and mothers who drives small children around. Those people are more vulnerable to physical injuries and large financial losses due to road hazard caused accidents.

Commercial users

The Hazard Spy application is also a valuable resource to corporate and institutional entities. While they do not need to report certain hazards, being able to access the real time hazard data provides insight to management to make key business decisions, gain competitive advantages, reduce maintenance and repair costs. Some examples of potential commercial customers of Hazard Spy are:

- Insurance companies who can use hazard data to adjust insurance premiums based on the "hazard level" of a specific area. They can also give out discounts on the premium to those who use Hazard Spy regularly to avoid road hazards.

- Once Hazard Spy acquires a sizeable user base and hazard data is uploaded to the server frequent enough, GPS companies who can subscribe and incorporate the hazard data from Hazard Spy into their routing features and automatically reselect a route for the drivers according on their tolerance level toward road hazards.

- Law firms who can use the historical hazard reporting data to build a stronger case against governments for negligence.

  According to a news article published on The New York Times: "The Pothole Law — passed in 1979 to make it harder for people to sue — protects the city from liability for injuries to people who trip or fall on sidewalks that are "out of repair, unsafe, dangerous or obstructed," unless a written notice of the defect has been provided to the city's Department of Transportation at least 15 days before the accident. Previously, the injured person only had to show, usually through witnesses, that the crack or hole or protrusion had been there long enough for the city to be able to fix it. As a result, the state's highest court ruled on Thursday that the association's famous pothole map was not sufficiently clear and therefore did not give two injured people the right to win civil judgments against New York City under the city's Pothole Law." [26]

- Emergency response units can use Hazard Spy to receive the latest traffic accidents and emergency cases. Hazard Spy is particularly useful for drivers who have smartphones with built-in accelerometer. Hazard Spy can submit the emergency request automatically when the driver is unable to dial a phone after the impact of an accident.

- Construction companies who can use Hazard Spy to source and plan projects

- Traffic news companies who can broadcast the latest hazard related data over the air

[26] Pothole Map Inadequate for Lawsuits Court Finds, December 18, 2008, Sewell Chan, The New York Times

Government

Finally, government can obviously benefit from the real-time hazard data. Most local governments in the United States have certain budget limits when it comes to road repairs and maintenances each year. Without Hazard Spy, government currently sends out contractors to patch up a stretch of roads every week. The frequency of these batch jobs is constrained by the budget and it's unlikely all of the roads will be covered during the harsh winter season.

Furthermore, some of the road that was planned for the later rounds of patching wouldn't receive a "rescue" until late in the winter. By that time, smaller potholes became gigantic ones that it would need more money from the government to patch up or may even require a complete repaving.

With Hazard Spy, government can monitor potholes and road hazards as they are forming in real time. With this capability, government can 1) send out contractors to cover the most hard-hit areas first instead of sending the crew out according to a pre-determined schedule, and 2) patch up the potholes while they are still small to avoid costly and less durable repairs later.

TOTAL MARKET SIZE

Hazard Spy fits into the greater Intelligent Transport Systems (ITS) market in the United States.

According to U.S. RITA (Research and Innovative Technology Administration), Intelligent transportation systems (ITS) encompass a broad range of wireless and wire line communications-based information and electronics technologies. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion, improve safety and enhance American productivity. [27]

ITS represents an estimated $80 billion market over the next 20 years. For the next decade, ITS spending in the US is estimated to be $27-30 billion. [28]

MARKET SEGMENTS

The Intelligent Transportation Systems (ITS) goal is to improve transportation safety by integrating systems with advanced communication technologies. Under the Umbrella of ITS, Hazard Spy covers the Obstacle Detection, Collision Avoidance, and Collision Notification sub-segments within ITS.

Hazard Spy's reporting system has applications in several industries. From government municipalities to insurance companies, law firms and GPS manufacturers, Hazard Spy simplifies the reporting of road hazards providing superior value to its customers.

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[27] http://www.its.dot.gov/its_overview.htm
[28] http://www.itscosts.its.dot.gov/its/benecost.nsf/CostComponents?OpenForm

The initial plan is to target the government municipality system in order to validate the technology's benefits. After successful testing of the product, the plan for Hazard Spy is to target general consumers via a direct download of Hazard Spy applications via mobile carrier's App Store. In the future, Hazard Spy can target additional market segment, such as insurance companies, law firms, GPS manufacturers, and fleet management systems via a data subscription service model. See table 1 for details of each potential market segments.

	Government Transportation	**Consumers**	**Insurance**	**Law Firms**	**GPS**	**Fleet Management Systems**
End User	• Municipalities	• Sports car owners • Motorcyclists	• Insurance Agents	• Lawyers	• Manufacturers	• Operators
Application	• Data for repair	• Real-time Hazard warning	• Calculating premiums	• Evidence for lawsuits	• Feature integration with current GPS systems	• Data to prevent damage to fleet
Benefits	• Increase accuracy • Reduce repair cycle • Ease of Use • Preventative benefits	• Pothole avoidance • Reduce the cost of repair	• Increase accuracy in calculating premiums	• Increase likelihood of winning lawsuits	• Increase safety for users using a GPS system	• Reduce costs associated with repair of fleet due to road hazards
Lead Customers	• IT department within DOT	• Motorcycle riders • Luxury car owners	• Geico • Allstate • Farmers	• All Law firms specializing in road hazards	• Garmin • Tom Tom	• All Fleet Managemen t companies
Market Characteristics	• Early adopters	• Early adopters	• Mainstream	• Mainstream	• Mainstream	• Mainstream
Size of Market	• $200M +	• $100M	• 100M	• 300M	• 50M	• 100M
Competition	• In house development • Call Center Solutions such as Siebel and Oracle	• XM traffic update • GPS traffic update	• Agencies that take physical pictures	• Agencies that take physical pictures	• In house development • Companies such as Lexus	• GPS vendors

Table 1: Details of potential market segments

Value Flow Diagram

Figure 7 illustrated the how values flow between the multiple stakeholders of the Hazard Spy.

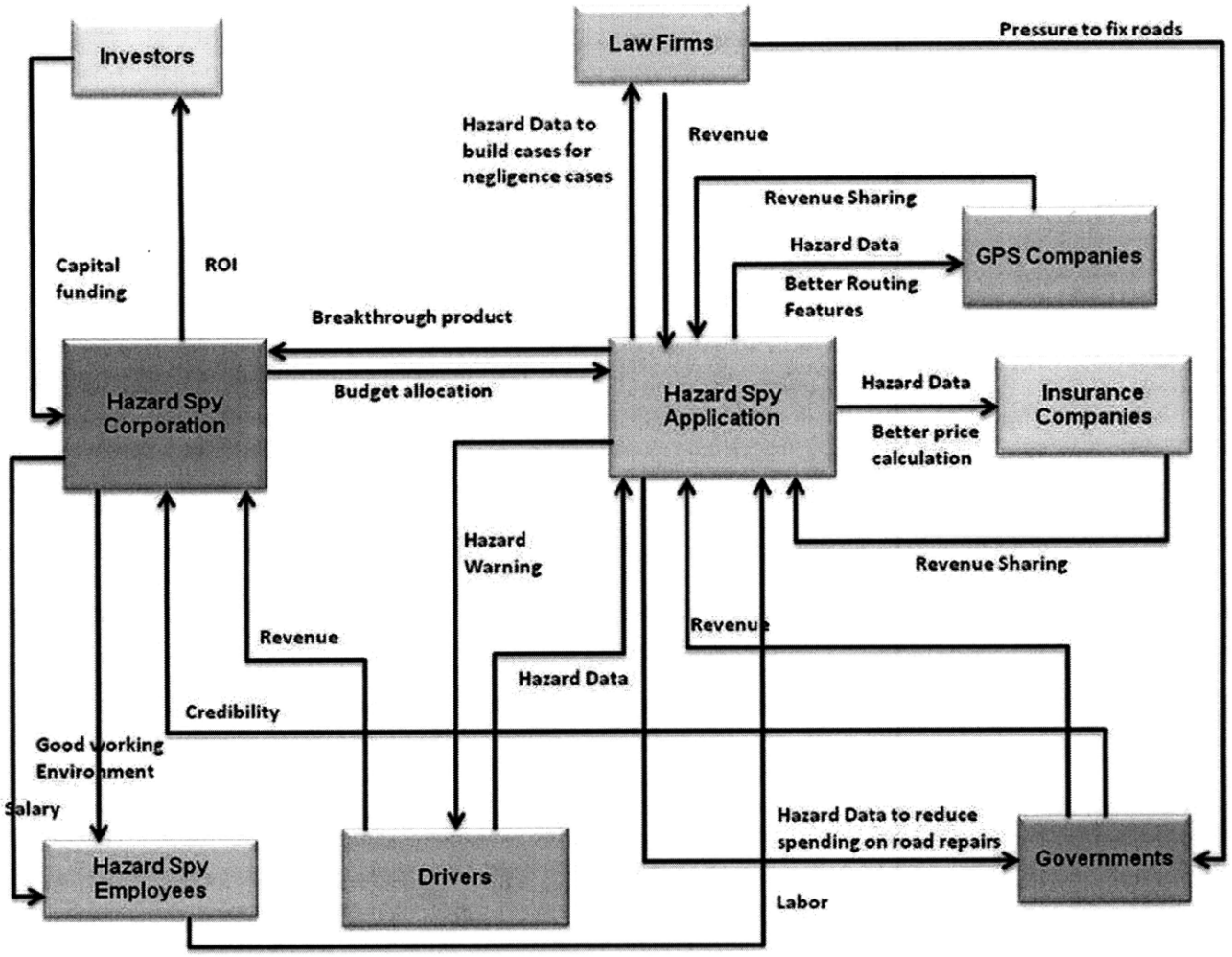

FIGURE 7: VALUE FLOW DIAGRAM

One interesting dynamic in this diagram is the relationship between law firms, governments, and Hazard Spy. In recent years, the pothole situation is progressively degrading. The number of cases filed against local municipalities for negligence has increased dramatically. Law firm has represented many drivers and build case against government for the damages caused by neglected road hazards.

Hazard Spy creates an extra role for itself in this relationship. While both law firms and governments are the customers of Hazard Spy, law firms receive values from the historical data of all hazard reports on file, while government gains value from the real-time hazard data that drivers reported while they are driving. However, because the addition of Hazard Spy, law firms can now put pressure on governments to repair the road as soon as possible, or to face litigation and potential public embarrassments. This added dynamic provides a positive feedback loop and is going to facilitate a faster road hazard response time, which will benefit the drivers and general public.

PRIMARY MARKET SEGMENT

Hazard Spy targets the hazard detection segment of the ITS market. More specifically, Hazard Spy will focus on pothole detection and target local municipalities as its primary customers at first. Based on calculations, the initial market size is estimated at $200 million or more per year. The detail of the calculation is demonstrated below:

> There are 8 Million paved lane miles in US. [29] The US Government spends over $3.5B every year on road maintenance and over $52B in non maintenance construction. [30] This $3.5B includes spending on information gathering, resurfacing, and pothole filling amongst others. Seattle and Denver Department of Transportation spend $1M annually in fixing potholes for the 4000 lane miles in their respective cities. Since pothole problem exists in both cold and temperate regions (New Orleans, San Jose, and Los Angeles are some of the top cities with most potholes), Hazard Spy can be used nationwide. [31]
>
> State and local governments are responsible for information systems to collect information about new potholes and other hazards on the road. It is estimated that Seattle spends over $100,000 per year on its pothole information management system. Using the total number of paved miles, it is estimated that the pothole information reporting and management system priced at the current alternative at $25 per mile is a $200M recurring annual market.

Even with this level of spending, the potholes reported by citizens are frequently hard to locate due to the inaccuracies that resulted from the manual process and other system limitations. A number of municipalities/counties are operating with a backlog in their scheduled road maintenance, resulting in an increase in the number and size of potholes every year. Because the budgets to fix these potholes are not increasing at the same rate, prioritization of potholes is becoming pivotal. Hazard Spy is a revolutionary technology that can help this situation by more accurately measuring the pothole severity and reporting the pothole location. Because of the accurate, automated, instant, and integrated reporting and tracking system, Hazard Spy will to be able sell the information system at a premium. If Hazard Spy can charge $35 per mile, the total addressable market will be **$280M** per year.

GROWTH TRENDS

Growth in hazard detection and warning market is determined both by a switch to Hazard Spy's technology as a superior road repair information source, and by the ever increasing number of potholes in the roads due to heavier use. Indeed, as our nation's ageing road network faces a continually heavier burden of traffic volumes and truck freight loads, the number of potholes on the roads will increase.

Between 1995 and 2005, the number of interstate motor carriers has doubled from 346 thousand vehicles to 680 thousand vehicles. For cars and trucks, between 1996 and 2006, the number of vehicle

[29] Transportation of the United State, nationalaltas.gov
[30] Annual Financial Statement, F 2007, US Department of Transportation
[31] Pothole Report Ranks Bay Area Roads as Second Worst in Nation, May 09 2009, KCBS News

miles traveled on urban roads increased considerably from 1,523,886 miles to 1,977,047. [32] With good maintenance practices based on the accurate information provided by Hazard Spy, however, roads can be repaired faster and with more accuracy - thus saving money on road repair. Though cities and towns nationwide have been having difficulty meeting their budget targets for road maintenance, Hazard Spy's accuracy will help cities and towns to stretch their budgets by locating and reporting on incipient potholes early, when they are cheaper to repair.

COMPETITORS:

Hazard Spy's competitors can be grouped into three categories

(1) Existing solutions: Most local and state governments in the United States favor call centers as their solution. These systems allow citizens/drivers to call in for hazard information and operators manually key the information into their central system or in some cases do manual logging of problems. There are commercial off-the-shelf solutions from software makers such as Siebel Systems and Oracle, which could adapt some form of automated entry of information into their systems in the future. In-house systems contribute to the other existing solutions for reporting hazards to the local or state governments, however they are seldom in use.

(2) Comparable competitors: Since Hazard Spy constitutes a more advanced technology, there are no directly equivalent competitors that are either in business or have received funding for development that have been identified. There are, however, companies that provide technologies that could be adapted to report hazards such as Bobcop, which develops mobile based phone reports. Other potential competitors are companies that offer GPS mapping solutions and could adapt their offerings to report/locate hazards assuming individuals provide them with the information, which in turn would be manual and not necessarily precise. Other companies such as Jabula from South Africa and GroRadar use different types of technologies to report hazards, but are not targeting road hazards in particular at the moment.

(3) Potential competitors: Some companies develop in-house GPS and tracking systems and that would have the interest to develop a solution built on their platforms. Some form of development or potential integration of technology in the future from GPS manufacturers is expected, as well as from luxury car manufacturers.

[32] http://www.bts.gov/publications/national_transportation_statistics/html/table_01_33.html

See table 2 for a summary of Hazard Spy competitors

	Type of technology	Example
Existing Systems	Commerical-off-the-shelf call center solutions	Siebel, Oracle
	Custom IT systems	Proprietary solutions either developed in house by IT staff, or outsource.
Comparable competitors	SMS based mobile phone reporting system	Bobcop, Ushihidi, Datadyne, Nijel
	High speed video sensing technology	Jabula
	Ground-penetrating radar	GroRadar
Potential competitors	GPS companies	Tomtom, Garmin
	Luxury car manufacturers	Lexus

Table 2: COMPETITORS OF HAZARD SPY

Hazard Spy's biggest threat of competition will emerge as a reaction to its idea and most likely not as simultaneous development. Further evaluation on potential competitive reactions and situations, as well as companies that might be in startup mode trying to address this market is needed.

PRODUCT FEATURE COMPARISON

Benefits of Hazard Spy

Hazard Spy has following advantages against its competitors:

1) Hazard Spy utilize a Smartphone's built-in accelerometer to detect recognizable movement patterns as potholes while people are driving, and reports the phone's GPS location automatically. Therefore, Hazard Spy is a safe, accurate solution.

2) Hazard Spy uses no additional hardware other than driver's cell phone, and no modifications to the vehicle. As a result, Hazard Spy is a cheaper solution for drivers.

3) Hazard Spy handles inbound data electronically. No call center representatives are needed to take inbound phone calls. Therefore, Hazard Spy is a more cost effective solution for the transportation authorities.

4) Hazard Spy can be used by average citizens. Therefore, Hazard Spy increases the hazard detection coverage area from traditional solutions.

Hazard Spy vs. Existing technologies

	In house development	Call Center Solution	Hazard Spy
Accuracy	Poor (using words to describe locations)	Poor (using words to describe locations)	Pin-point GPS Coordinates
Ease of use	Poor (must call in)	Poor (must call in)	Automatic (reports are triggered by accelerometer movements, no user input is needed)
Cost	High (IT staff + call center staff)	High (outsourcing cost + call center staff)	Medium

Hazard Spy vs. Comparable Technologies

	SMS Based	Video Sensing	Radar	HZ Spy
Accuracy	Low (most doesn't use GPS)	Good	Good	Pin-point GPS Coordinates
Extra Hardware	Your cell phone	High speed camera	External Radar	Your Smartphone
Ease of use	Poor (typing long SMS)	Need manual processing	Good	Good
Cost	Low	High	High	Medium
Who can use it?	All cell phone owners	Only professionally equipped vehicles	Only professionally equipped vehicles	High end smart phone owners

Hazard Spy vs. Potential Competitors

	GPS companies	Car makers	HZ Spy
Extra Hardware	External GPS units that must by GSM enabled	Installing sensors on suspension and tire	Only your Smartphone
Accuracy	Good	Good	Good
Ease of use	Good	Good	Good
Cost	High	High	Medium
Who can use it	Next generation of GSM-enabled GPS owners	Limited number of luxury car owners in the future	All smartphone owners

ENTRY STRATEGY

Initially, Hazard Spy will deploy a beta version of the product in the public sector for 6 month. Simultaneously, the beta version will be open for public download and it will be free of charge for 6 month. Therefore, the initial end users of Hazard Spy can be divided into two sections: general consumers and institutional users.

Delivering the Hazard Spy client application to general consumers is a simpler value chain and distribution channel. For the mobile phones that Hazard Spy is targeting, mainly iPhones, Andriods and Blackberries, almost all of the applications are distributed through App Stores. Users know and are familiar with buying and downloading applications from App Stores. Apple recently spent a large amount of its budget on TV advertisements featuring a wide variety of applications and its App Store, adding another built-in benefit of distributing Hazard Spy via App Store.

As for reaching institutional users, a dedicated sales team will be needed. Selling to institutional clients will require a longer sales cycle, but the amount of revenue each account bringing in will be much larger than individual consumers. Another added benefit of serving institutional clients is the associated positive PR (public relation), which will help increasing the viral marketing effects in the general consumer segment.

One of the characteristics of Hazard Spy is crowd-sourcing, which means it relies on the general public to gather information. Hazard Spy requires a certain number of users running the application in order to produce accurate pothole maps. The plan to achieve the threshold of initial users is to give the

application and hazard data to city or local municipalities for free. In exchange, government will install and run the Hazard Spy application on city buses, mail trucks, and/or police cruisers.

Hazard Spy will target the West Coast first, especially cities such as San Jose, San Francisco, Seattle, etc. The reasons for targeting these cities first are: (1) these are the top cities in the nation for the most potholes reported; According to Pothole Report by TRIP and the American Association of State Highway Transportation Officials, Bay Area roads is ranked second worst in the nation. Transportation California estimates that poorly maintained roads costs Bay Area each driver $700 annually for vehicle maintenance in the region's three largest cities. (2) consumers in these cities are more likely to adapt to newer technologies; (3) the penetration rate of high-end smart phones, such as iPhone and Andriod, is higher; (4) auto insurance and auto repairs are generally more expensive in these areas. 5) Pothole problem is not concentrated in winter months, therefore, creating some seasonal balance. Thus, West Coast consumers are facing severe potholes issues, they own the equipment already, they are willing to try new things, and the cost of not using Hazard Spy is high.

EXPANSION STRATEGY

Hazard Spy will build on its success on the West Coast and then expand into the Northeast and Midwest. These two regions also face severe winter weather patterns, so potholes are a pressing problem for the citizens. Some of the states in these regions also have strict auto safety regulations, which require vehicles to pass annual safety inspections. Hazard Spy will help drivers avoid hazards that can cause their cars to fail these inspections.

Potholes are most prevalent during winter and early spring for Northeast and Midwest and during late Spring and summer for temperate regions. To minimize seasonal imbalance, Hazard Spy will allow users to report on hazard information other than potholes- for example, road accidents, dead animals, debris, and perhaps speedtraps, red light cameras, etc. This kind of information will be useful to drivers all year long. Hazard Spy can also offer discounts to customers for downloading the application during the summer.

PRICING

Hazard Spy will charge general consumers $9.99 per download from the App Stores. This is a one-time fee, per download, per device- and includes a data subscription and future software updates. However, if user changes their phone, the Hazard Spy application will need to be repurchased. For commercial users, the price will vary based on add-on features and customizations.

Charging users on a per-download, per-device basis is Hazard Spy's chief strategy. On average, people change their phones when they change/renew their wireless plan, an event which usually occurs every 2 years. In addition, cell phones and, mostly importantly – batteries - don't have a long life expectancy.

The shorter battery life leads to frequent purchasing of new phone. Therefore, after accounting for a customer attrition rate, it is estimate that $9.99 per user will be a recurring source of revenue every two years.

According to a study done by PinchMedia, there were 652 applications launched in the Apple App Store in 2008 (reported on July 11, 2008). [33] Figure 8 shows the pricing distribution for these newly launched applications. Notice that there was a significant drop off in the number of applications that cost more than $9.99. This is the major reason for pricing the application at $9.99, instead of at a higher price.

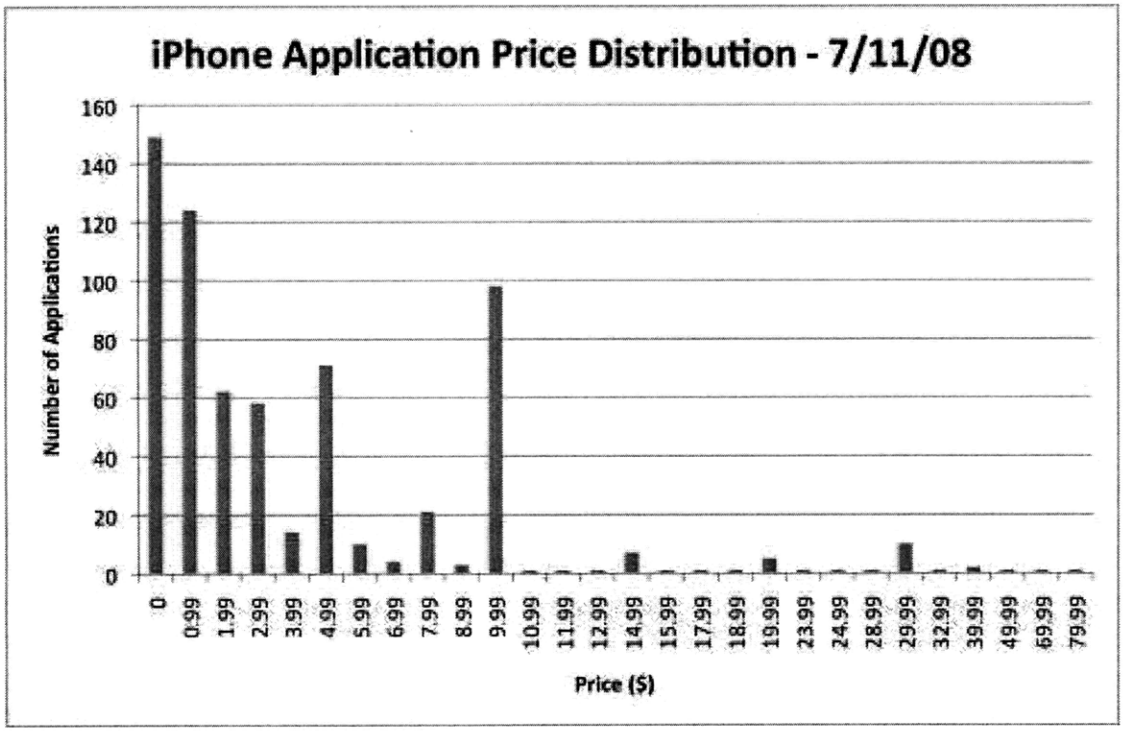

FIGURE 8: IPHONE APP PRICE DISTRIBUTION

There is no direct competitor that offers road hazard data to consumers. However, there are a few companies that provide other traffic and road related information.

1) ***Traffic Alerts***: These services are usually offered by GPS companies such as Garmin and TomTom. The subscription cost of traffic alert services is usually around $60 a year after one year when the bundled service expires from the initial purchase of the GPS unit. The GPS unit itself ranges from $200 to $600.

2) ***Red Light Camera Warning Database***: Companies (Escort and Beltronics) that offer these kinds of services charge $12 – $15 a year. However, the service only works with their proprietary laser detectors, and these detectors cost around $300 - $500.

[33] http://www.pinchmedia.com/fresh-pricing-data-7-11-08/

Hazard Spy's price of $9.99 for the lifetime of a phone appears small compared to the cost of these services. In the future, Hazard Spy can sell hazard data subscriptions to the GPS companies and Red light camera companies through either partnership or revenue sharing arrangements.

Both Google and Apple will take a 30% cut from the application sales in their App Store. The new Blackberry stores will have a similar commission structure. The cost of web hosting and bandwidth is very minimal today. Since Hazard Spy uses GPRS instead of SMS, there is no messaging cost. Therefore, it is estimated that gross margin for Hazard Spy will be close to 70%. At 70%, the gross margin appears to be in the ball park of other internet and mobile based companies, and it will provide enough wiggle room to cover fixed costs based on some back-of-the-envelope calculation. The full cost structure will be described in further detail in the finance section of the thesis.

The Enterprise Version of Hazard Spy will have significantly more features than the general consumer version simply because the Enterprise Version has a back end that allows users to login from a standard browser and perform various tasks. The Enterprise Version will be priced at $40 for an annual subscription per account. In general, the Enterprise Version will include following features in addition to the hazard reporting and warning features that packaged with consumer version.

- Advanced data visualization, including data filtering on hazard category, date reported, and hazard severity.
- Statistical tools for analyzing historical trends of hazard occurrence
- Historical data on hazard reported for each vehicle in a fleet

SALES STRATEGY

Sales Team

For general consumers, there is no need for a dedicated sales team. Viral marketing and App Store advertising takes care the marketing and distribution to the consumer segment.

Hazard Spy will sell the product to institutional users through the use of sales representatives to address the initial adoption by lead customers from government, taxi, freight transportation, and logistics companies. The following eight initial lead customers/users:

Government/Public institutions

MBTA & Boston transportation agencies

Taxi companies

Yellow cab San Francisco & Yellow cab Seattle

Freight companies

JB Hunt & Con-Way

Logistics companies

UPS & Fedex

The plan is to employ the government institutions to provide the initial database of potholes by delivering the Hazard Spy system free of charge. This would allow Hazard Spy to test reliability of the system in addition to populating the database with pothole locations. Since no commercial transaction will take place, a significant amount of experience should be acquired before addressing other institutional users. Soon after, the application will be available for a free 6-month trial license to consumers.

In selecting commercial customers, Hazard Spy has the potential to monetize revenue from the application, once a significant database of potholes is available and the service can offer values to these companies. The plan focuses on lead customers from 3 types: taxi companies, freight companies, and logistics companies. It is expected that these customers will generate significant word of mouth advertising, and drive a significant flow of users and attention to Hazard Spy. Similar initiatives in the future will focus on obtaining lead customers in key cities to lead the expansion.

Expansion and Building the Sales Team

The initial direct sales team would consist of an external sales representative and an internal sales rep. This will allow for new business development as well as continuous support and sales over the phone at any time. Eventually, Hazard Spy will expand the sales team to encompass customer service, telesales, and international sales.

Expansion to the US sales team will be based on geography and leveraging SAAS tools such as salesforce.com to allow for reduced costs and maximum mobility. The main geographical distribution will be based on driver/car densities as well as weather conditions that cause potholes. Initial division would be West Coast, then expanding into New England, Mid-Atlantic, Upper Midwest, and International. The international division will have the duty of finding partners in targeted markets that can allow for customizing to adapt to local regulations and conditions, while maintaining customer and technical support to remain in Hazard Spy.

Telesales will have the role of maximizing the lead customer reference and expanding to smaller players within particular city markets, while customer service will ensure continued contact and attention to those lead customers.

ADVERTISING AND PROMOTION

Hazard Spy's advertising and promotional activities will target both general consumers and commercial users.

Initial Ad Campaign:

Potholes are the source of an enormous amount of frustration and anger for drivers, and a humorous and irreverently-themed ad campaign called "Potholes Suck" that plays to this sentiment through exaggerated scenarios of potholes that literally "go straight through to China" and other humorous

content will be used. The advertising campaign should be very popular, and create buzz by word of mouth. As detailed below, both traditional marketing techniques – print, billboard, and radio, as well as viral techniques (chiefly by way of a Youtube video) will be used.

Modes of Delivery

Billboards and Radio

Danger from potholes and road damage is most acute when people are operating their vehicles, and thus they will be most receptive to learning about Hazard Spy while in their cars. To target customers while they are driving, highway billboards in urban areas will be used, along with side of bus advertising, and radio ads during rush hour.

Print Media:

Automotive magazines: Automobile enthusiasts love their cars and make significant investments in them. High performance vehicles are often fitted with tight suspension, low profile tires, and expensive rims – all of which are especially prone to pothole damage. Advertising in publications for car enthusiasts will be used with the message that Hazard Spy can protect their investments and their peace of mind.

Technology Magazines and Blogs: Advertising in technology gadget magazines and blogs, such as Tech Crunch and Gizmodo, will be used. These sites attract an enormous amount of attention from technology enthusiasts, and will give the Hazard Spy product & service a considerable amount of positive exposure.

Parenting Magazines: Potholes present a serious safety hazard, and parents are especially receptive to ways in which they can reduce the risk to their children. Accordingly, parenting magazines will be targeted for advertising.

Internet

Hazard Spy website will feature product and service information, an application download and purchase section, and will have the humorous "Potholes Suck" viral video posted both on company website and on Youtube. Used in conjunction with radio and billboard advertising, it is anticipated that the video will go viral and render exponential advertising and promotional gains. Google Adword advertising will also be sued to draw people to Hazard Spy from search engines.

Trade Shows

Booth space will be rented at consumer electronics and ITS trade shows to promote Hazard Spy to tech enthusiasts, and to expand awareness of the product to fleet and commercial users. Hazard Spy will also participate in Trucking and transport trade shows to raise awareness among fleet owners and managers.

DISTRIBUTION

Distribution of the Hazard Spy application to target phones will be through the App Store of both wireless carriers such as AT&T, Verizon etc. and those of smart phone manufacturers such as Apple and Blackberry. Customers will download the Hazard Spy application for a fixed fee and will receive additional software updates for free as new features are added. For unlocked phones and 'jail-broken' phones, customers can download the Hazard Spy application through Hazard Spy company website. As detailed in the above section, a combination of viral marketing techniques such as videos on YouTube and traditional marketing techniques such as radio, billboards will be used to drive customers towards the application stores where they can download Hazard Spy. For large commercial customers, there is a possibility that the application interface to their existing devices and infrastructure can be customized for additional charges.

PRODUCT OVERVIEW

What is the product?

Hazard Spy is a service that allows users to subscribe to and receive information about road hazard locations. Hazard Spy consists of two components: 1) a client software application that runs on a user's mobile phone and collects and reports road hazard information in real time; 2) a server component that aggregates information from the data that users report, and produces an up-to-the-minute hazard map which it publishes via a wireless cellular network to its subscribers.

How does it work?

Hazard Spy client software can report a hazard in two ways

1) Hazard Spy can utilize a mobile phone's built-in accelerometer to detect disruptive movements from inside of a vehicle. When a driver starts driving, he will launch the Hazard Spy application on his cell phone and place it on the dashboard or some hard surface that is relatively flat inside the vehicle. When users drive around with the Hazard Spy application turned on, it will register abrupt vertical and lateral movements of the vehicle, acquire the current GPS location on the phone, and report the incident to the Hazard Spy server via a wireless cellular network.

2) For phones have no built-in accelerometers, Hazard Spy application will include a selection menu in the home screen that allows users to pick a type of hazard and click a send button to send in the hazard report.

Once the data reaches Hazard Spy server, it will be held in a 'staging area' temporally, until a second incident at the exact same location is reported to Hazard Spy. The server will then analyze the movement pattern of these incidents and determine whether they are from the same type of hazard. If the pattern and location matches, the hazard location is validated and data will then be published to alert users.

Hazard Spy is implementing what is essentially a 'crowd-sourcing' system with a proprietary validation scheme that checks for duplication.

After a hazard location is validated and published, the data can be accessed in two ways:

1) A paid subscriber can login to Hazard Spy via the Internet and browse the aggregated hazard data, along with different analytics.

2) Mobile users will receive hazard data automatically when they launch the Hazard Spy application on their phones. Based on the user's current position and the direction of travel, Hazard Spy will deliver voice warnings about the approaching road hazards ahead.

What is unique about it?

Hazard Spy is unique in three ways:

1) Unlike other competitors, Hazard Spy utilizes the built-in accelerometer in currently available advanced mobile phones. There is no additional hardware purchase other than the phone that customers already own. There is no hardware installation or modification to their cars. Other competitors require users to purchase a dedicated external device that must be mounted on the vehicle to sense movement, or modify their cars by installing an extra sensor on the car's wheels or suspension.

2) Hazard Spy is perfecting the validation technique on the server side. As mentioned above, Hazard Spy will validate reported events by checking for duplication, which involves a machine intelligence that can build a portfolio of patterns for different road hazards over time.

3) Hazard Spy will disseminate hazard information to mobile clients based on their current location and direction of travel. Most competitors are a "one-way" street, in that they only allow users to report data, but do not allow them to subscribe to it in real time. For those that allow mobile subscriptions, it's often a fixed location subscription, instead of a dynamic feed. For example, they allow users to subscribe hazard locations for zip code '02139'. However, if a driver travels to a new position, she needs to subscribe to a different set of data with a different zip code. Hazard Spy allows mobile subscription on-the-go, with no manual input required by the users.

ARCHITECTURE

Hazard Spy runs on a distributed platform. The architecture of Hazard Spy can be divided into the same three layers: client, server, and data. See Figure 9 for Hazard Spy architecture diagram.

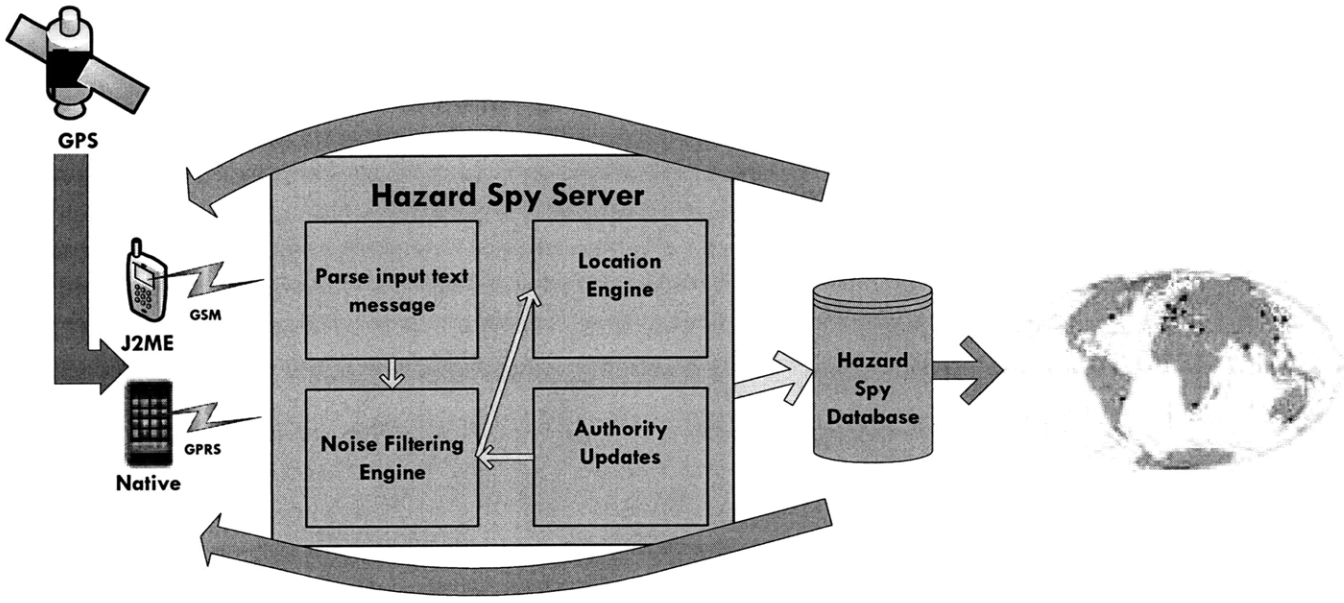

Figure 9: Hazard Spy Architecture Diagram

Scopes for each layer are as following:

- **Client:** Hazard Spy will provide a native interface (for Smartphones with accelerometer) or J2ME interface (for non-Smartphones and phones with no accelerometer) on the mobile handsets. The client application is responsible for detecting movements from the accelerometer readings or accepting inputs from the users, obtaining GPS coordinates from build-in GPS receiver on the phone or external GPS units connected via Bluetooth, constructing message packets, and sending data to the Hazard Spy server via raw HTTP communication. The HTTP is connected via wireless provider's data network, i.e. GPRS or 3G.

  The Hazard Spy client application will also ping the Hazard Spy server every 30 seconds with its current location coordinates. The Hazard Spy server will determine the client's direction of travel by checking the last three pings, and send an update-to-the-second hazard map for the immediate 3 miles radius.

  Once the Hazard Spy client receives the hazard map, it can then send a voice prompt via mobile phone's loud speakers and warn drivers about the upcoming dangers.

- **Server:** The sever component for Hazard Spy will contain a GPS decoding engine and a Noise Filtering technology that will rank users based on his or her historical reporting and will determine the validity of each reported hazard by checking for duplicate entries.
- **Data storage and Data Visualization:** Filtered hazard data will be stored in a database and can be presented in map platforms (such Google Map or Google Earth) to paid subscribers. Data can also be pulled by each mobile client, which then announces a warn message if a hazard is near.

TECHNICAL DETAILS

Client Side Processes:

Process 1: Sending hazard reports

1) Accelerometer detects any excessive movements of the mobile phone and triggers the process of sending hazard data, or a user inputs hazard data into a J2ME input screen, which triggers the process of sending hazard data.
2) Hazard Spy client application gets GPS coordinates from mobile phone's built-in GPS receiver or external GPS units.
3) Hazard Spy client software opens HTTP connection and send data to Hazard Spy server by embedding the database in the query string portion of the URL.

Figure 10 shows the process of sending hazard data.

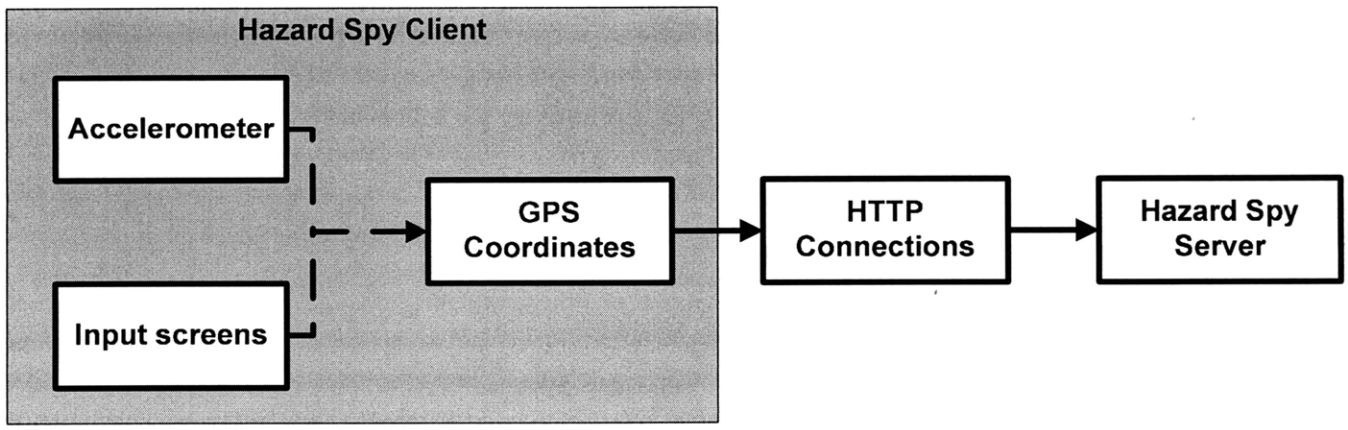

FIGURE 10: PROCESS OF SENDING HAZARD DATA

Process 2: Receiving hazard warnings

1) Hazard Spy client gets GPS coordinates from mobile phone's built-in GPS receiver or an external GPS unit.
2) Hazard Spy client sends its current GPS information to Hazard Spy server via HTTP.
3) Hazard Spy server retrieves the real time hazard locations within the 3 miles radius of client's current location.
4) Hazard Spy Server sends the location data to the client via HTTP
5) Hazard Spy client keeps tracking its GPS location in the background and send a warning message to the driver if a hazard is near.

   See figure 11 for this process.

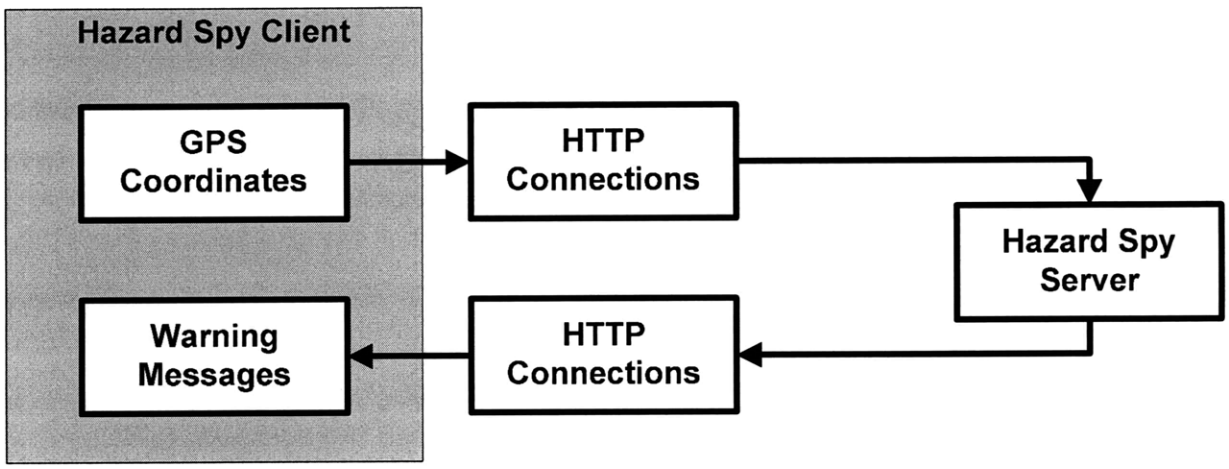

FIGURE 11: PROCESS OF RECEIVING HAZARD WARNINGS

Client interface

Reporting interface

Hazard Spy has two types of reporting interface

1) **Automatic reporting.** This interface is relative simple, since there is no manual input required from the user. Users can launch the Hazard Spy application from Smartphone's desktop and place it on the dashboard of their car. The application will automatically report hazards when the vehicle has abnormal movements.
2) **Manual reporting.** This client interface is built in J2ME and consists of a panel, which can be used to submit hazards and view hazards.

a) **Submit hazards:** When a road hazard is spotted, drivers can simply look down and select the type of the hazard. Users either tap the screen on touch screen phones or push up-and-down selection buttons on non-touch screens. Users can optionally select severity level of the hazard, which is defaulted to "1". As soon as the "Send" button is pushed, Hazard Spy captures the GPS coordinates and constructs a query string that consists of all the data required to report a hazard. See figure 12 for hazard submission interface.

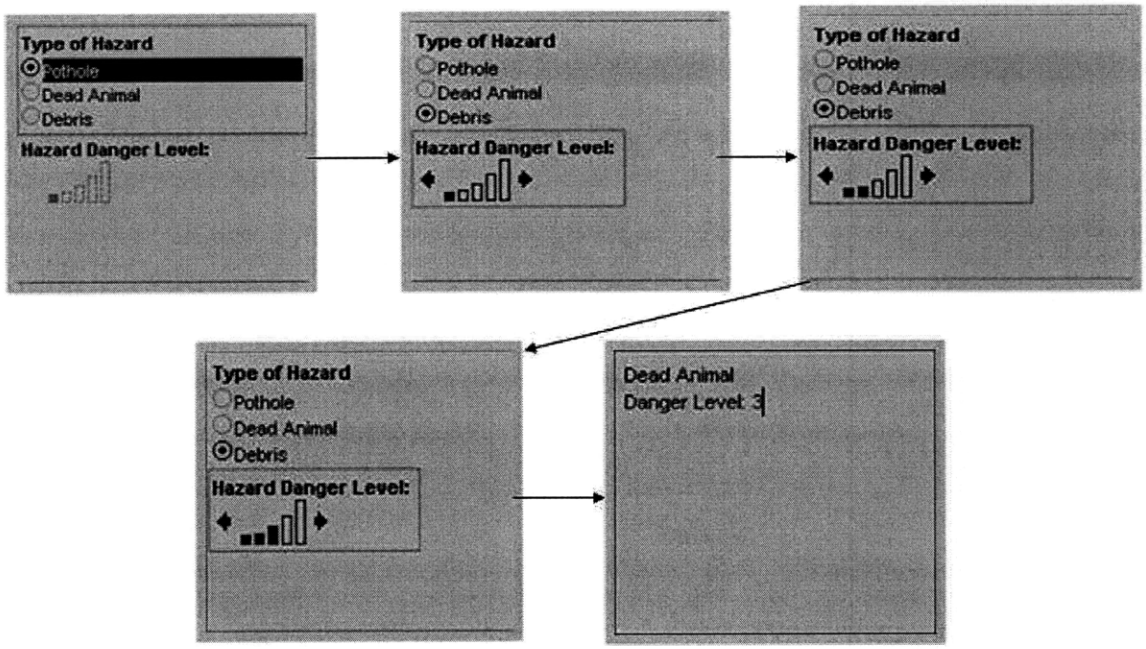

FIGURE 12: MOBILE CLIENT J2ME INTERFACE

b) **View hazards:** The View hazard interface will display a picture of all up to the second road hazards that are within certain vicinities of the current GPS coordinates. (See figure 13 for the view hazard interface)

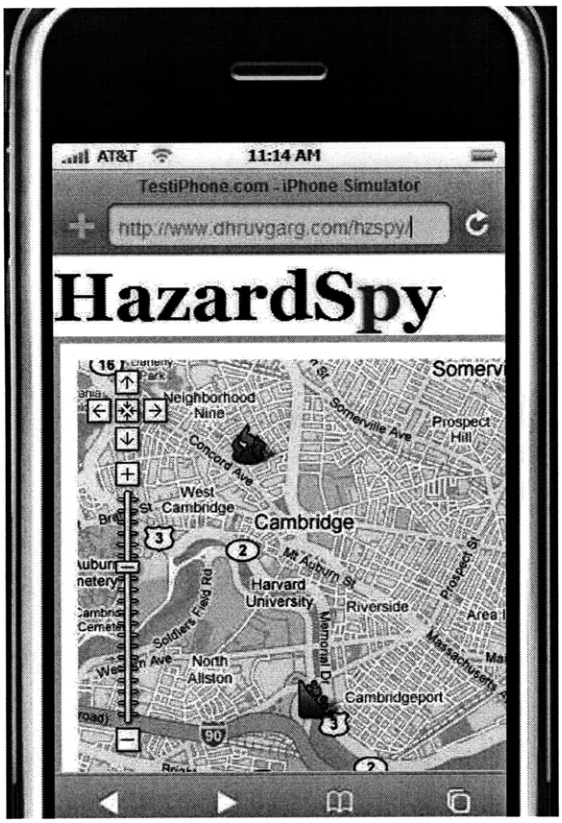

FIGURE 13: VIEW HAZARD INTERFACE

The road hazards that are located on the Map will be represented by different icons, informing the driver and passengers of the types of potential road hazards on the way. See figure 14 for list of icons.

Pothole

Accidents

Debris

FIGURE 14: HAZARD SPY ICONS

These icons will be continually updated and as potential hazards are removed, the icons will be removed from the map. If there exists any major hazards such as a massive traffic accident/flash floods that may pose imminent danger to the driver, the interface sends out voice warnings.

Client Side Components

GPS

There are two ways for Hazard Spy to get GPS coordinates.

1) Retrieve coordinates from a built-in GPS receiver on the mobile phone

   Getting GPS coordinates from built-in receivers is relatively simple. All Smartphone manufacturers include Location API's if the phone has a built-in GPS receiver. For example, the iPhone has a Core Location API in the iPhone Development SDK.

2) Retrieve coordinates from external GPS units via Bluetooth

   Getting GPS coordinates from an external receiver via Bluetooth is more complicated. Hazard Spy's GPS service is a modular piece of software capable of integration with any external service that requires a Bluetooth GPS connection. It was constructed to serve as a standalone intermediary between software and hardware. The primary GPS class utilizes an NMEA string parser to extract target information from NMEA string sentence broadcasted by the Bluetooth unit. Hazard Spy's data structure to store coordinates is the Location class, which holds information pertaining to longitude, latitude, direction, and time. A typical NMEA sentence in the GPGGA format looks like the following:

   ```
   $GPGGA,123519,4807.038,N,01131.000,E,1,08,0.9,545.4,M,46.9,M,,*47
   ```

   The role of the NMEA parser is to make sense of the example string above and extract the coordinate information that Hazard Spy is interested in mapping. Due to the fact that a user could be sending information to the server while the location is being changed at the same time, all updating processes are synchronized to prevent compromising the data structure.

   Figure 15 visually summarizes the relationships between the processes mentioned in the above design:

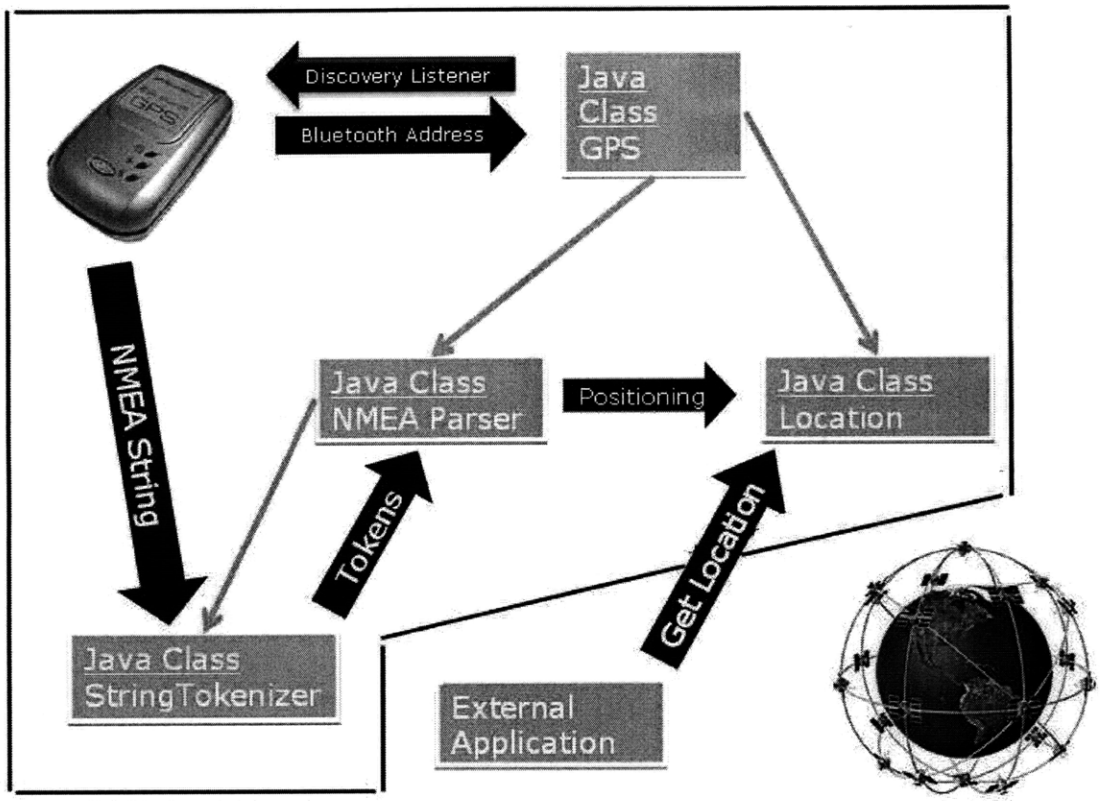

FIGURE 15: HAZARD SPY GPS COMPONENTS

The detailed functions of three required Java classes are illustrated in figure 16.

GPS.java	NMEAParser.java	Location.java
• Establishes connection given Bluetooth URL and a log to store readings • Synchronized connections • Threaded processes • Implements runnable	• takes a single NMEA string sentence and breaks it down by field using a StringTokenizer • Stores individual fields into a Location object instance	• latitude • latitudeDirection • Longitude • longitudeDirection • dateTimeofFix • dataStatus

FIGURE 16: J2ME CLASSES FOR RETRIEVING GPS COORDINATES FROM EXTERNAL UNIT

Accelerometer

Hazard Spy can utilize mobile phone's built-in accelerometer to detect excessive motions. Hazard Spy requires a 3-axis accelerometer, as the one shown in figure 17. A 3-axis accelerometer is required by Hazard Spy because it allows drivers to place the mobile phone in any orientation inside the vehicle. In addition, a 3-axle accelerometer can detect motions in any direction so that Hazard Spy can capture a rich array of direction data, which can be feed into its algorithm to determine what type of road surface condition it is encountering.

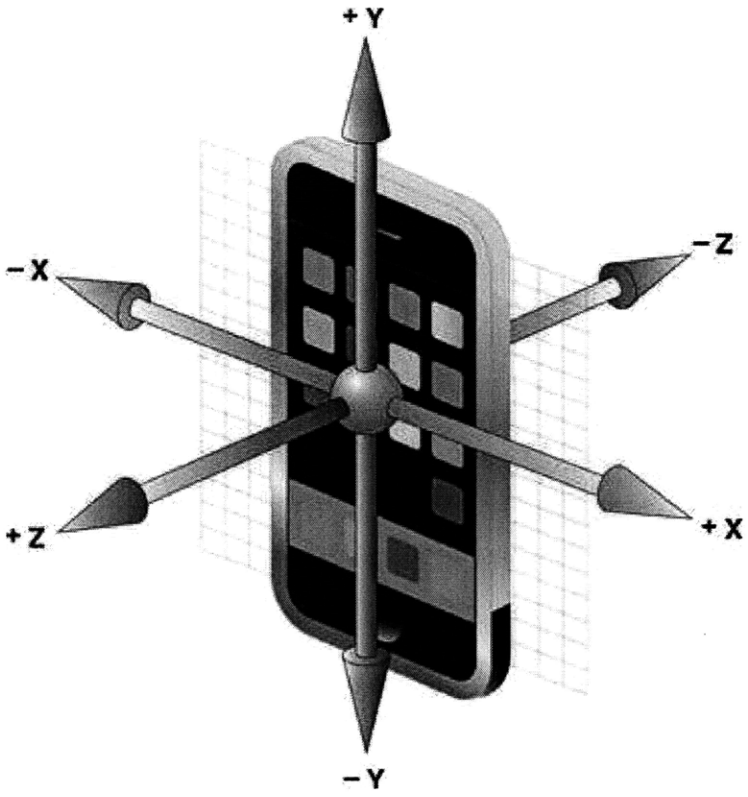

FIGURE 17: 3-AXIS ACCELEROMETER IN IPHONE

Currently, the accelerometers in most of the Smartphones (such as iPhone and Andriod G1) are 3-axiss type and are very sensitive to movements. For example: iPhone uses model LIS302DL, a high-end motion sensor manufactured by ST Microelectronics. The LIS302DL is an ultra compact low-power three axes linear accelerometer. It includes a sensing element and an IC interface able to provide the measured acceleration to the external world through I2C/SPI serial interface. According to product specification, the LIS302DL has dynamically user selectable full scales of ± 2g/± 8g and it is capable of measuring accelerations with an output data rate of 100 Hz or 400 Hz. [34] The accelerometer has a sensitivity of approximately 0.02g and a range of ±2g making the iPhone and iPod touch sensitive enough to analyze the vibration of most moving machinery. [35]

[34] http://www.st.com/stonline/products/literature/ds/12726/lis302dl.pdf
[35] http://macresearch.org/showcase-vibration-turns-your-iphone-spectrum-analyzer

For reading movement data from the accelerometer, mobile phone manufacturers supply a rich set of API's as a part of the developer's SDK. For example, the iPhone provides every application a single *UIAccelerometer* object that can be used to receive acceleration data. [36]

Reading data from accelerometer is relatively easy, however matching accelerometer movement pattern to actual road hazards is extremely difficult. For example, Hazard Spy must distinguish running over a pothole from not only accidently dropping the phones but also running over other types of road hazards, (such as a dead animal). The granularity of different kinds of hazards can help local governments to send appropriate contractors into action. Simply reading all large spikes on the accelerometer and treating them as road hazards is not acceptable.

To match movement patterns from accelerometer to hazard types, a large amount of road test is required. This means an easy way to visualize and to log accelerometer readings is a must. Luckily, there are two free tools for iPhone that can serve this suppose.

1) Vibration

Vibration is a true vibration spectrum analyzer using the built in accelerometers inside the iPod Touch and iPhone. It acquires and displays time series data, optionally removes DC bias, applies a Hamming window and performs an FFT on each channel to produce frequency spectra. The frequency data can be viewed in linear-linear, log-linear, linear-log and log-log format. You can turn on and off the display of each axis individually. You also have the option of applying a Hamming window. All of these options can be modified after data acquisition, making it simple to view the data in a variety of different formats. [37]

Figure 18 displays a reading on Vibration for an upward movement, when the Y axis records a much stronger force than X and Z axis.

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36 http://developer.apple.com/iphone/library/documentation/iPhone/Conceptual/iPhoneOSProgrammingGuide/AdvancedFeatures/AdvancedFeatures.html

37 http://macresearch.org/showcase-vibration-turns-your-iphone-spectrum-analyzer

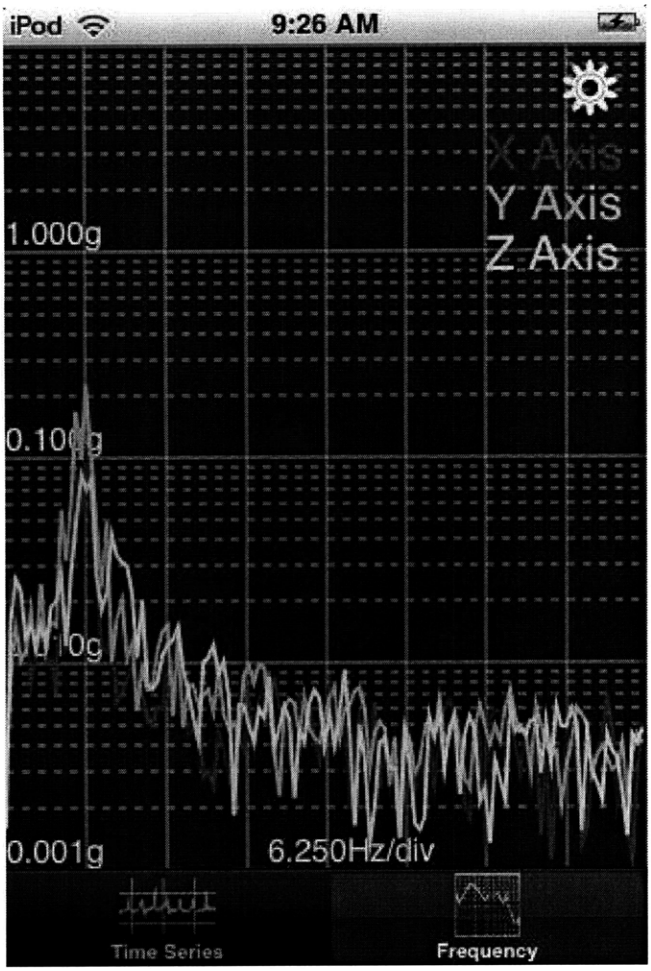


FIGURE 18: A SAMPLE READING FROM VIBRATION SOFTWARE

2) Accelerolog:

Accelerolog is a very similar application to Vibration. The advantages of using Accelerolog is that it displays X, Y, and Z axis separately, and forces recorded by each axis are displayed on top. This helps users to get the data more quickly and precisely. Figure 19 displays a sample reading from Accelerolog.

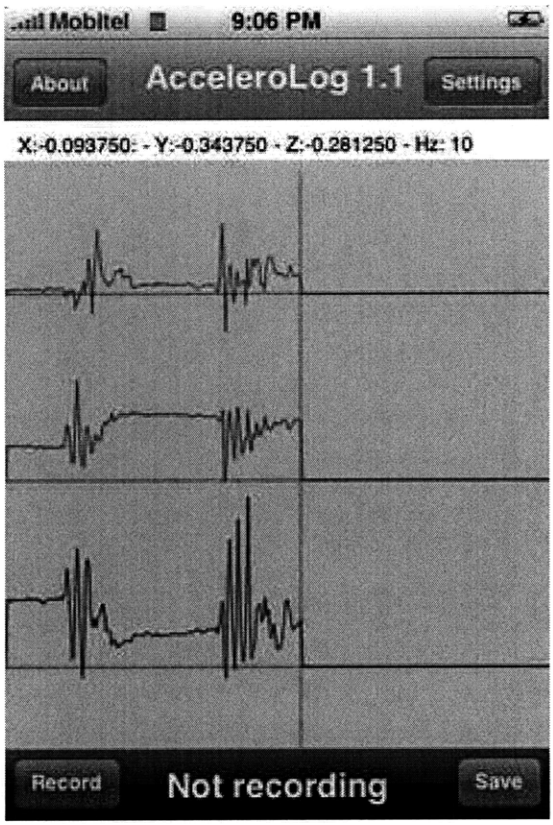


FIGURE 19: SAMPLE READING FROM ACCELEROLOG

Server Side

The server side component has the input of a query string sent from a user via HTTP, and has the output of storing that data appropriately in the MySQL database.

Step 1: Parse the query string

The query string will be automatically generated based on the user inputs in the client interface, allowing a standard parsing function to be used across all hazard reports. The syntax of the query string is displayed below:

`http://www.hzspy.com/addData.php?lat=[VAL]&long=[VAL]&type=[VAL]&level=[VAL]&ESN=[VAL]`

These values will then be sent as inputs to a PHP script on the server which will add them to a database listing all the pending hazards with unique IDs assigned to each hazard, the hazard type, the coordinates, the phone number of the submitter, the timestamp, a count representing number of reports for this hazard, and isValid which is default false, and isFixed which is default false. Following is a possible table structure for this:

[hid | hazard type | long | lat | ESN | timestamp | count | isValid | isFixed]

Note: Due to potential privacy concerns, Hazard Spy only ESN (Electronic Serial Number) of the mobile device and no other personally identifiable information of the submitter.

Step 2: Noise-canceling engine

The purpose of the noise-canceling engine is to validate the accuracy of a hazard report. This is a crucial part of the system as the reliability of this engine determines the quality of the hazard data. Each new user will get a threshold of one hazard, which means that if that user is reporting a hazard for the first time, that hazard will automatically be validated and isValid will be 'yes.' For subsequent hazard requests from the same user, a validation by at least one other user who sends in location coordinates within a set vicinity of longitude and latitude values is needed before making that hazard valid.

Over time, each user account (identified by ESN) will be given a "credit rating", which will be fed into a noise-canceling algorithm to determine the extent of verifications needed for a hazard to be valid. The user rank is currently implemented as:

```
user_rank = (number of successful reports - number of pending reports)*percent success
```

Clearly, the user rank takes into account the frequency of reports as well as the accuracy. Higher rank values are directly correlated with the reliability of the user.

Step 3: Location Engine

The location engine will periodically traverse through the entire database and look for valid hazards that haven't been fixed. It will populate the temporary table with the hazard type and location and convert the longitudinal and latitudinal coordinates into expressions that can be accurately represented with the Google Maps API.

Step 4: Authority Updates

The hazard location data will be shared with government authorities on a real-time basis for quick rectification purposes. Once government authorities feel that they have resolved a hazard, they can log into Hazard Spy and update the Hazard Spy database. In addition, maintenance crews can notify Hazard Spy about the fix via a text message. There is a possibility that there might be no hazard there is the first place, and the authorities will have a way of reporting this by sending a SMS while they are outside doing investigation.

[isHazard] [Longitude] [Latitude] [Authority]

This data is then parsed and fed into the noise-canceling engine. If there was a hazard, the hazard in the database in the vicinity of the input coordinates is 'fixed.' If there happened to be no hazard, the validity of the hazard in the vicinity of the input coordinates is switched to 'false.' As a result, the respective phone number's accuracy ranking goes down in the future, requiring greater verification for future reports.

Visualization

The visualization component consists of overlaying the valid and un-fixed hazards on an interactive real-time based web-based mapping application based on the coordinates fed in from the location engine. For the purposes of this application, Google Maps API seems fit.

Data Visualization component provides following features:

- The marker on the map should be color-coded to represent different types of hazard. Corresponding color-coded text of hazard names are displayed on the side.
- Hazard types can be selected or deselected by the users, and corresponding markers will appear or disappear from the map.
- Markers can also be filtered out by the date range below, with pre-configured options of 1 hr, 4 hr, 12 hr, 1 wk, 1 mo, and 1 yr.
- Mouse over a maker on the map would have a pop up displaying the details of the event (timestamp, severities, etc.).
- When user double clicks on a particular point on the map, a pop up with the zoom-in view appears for the proximity of the area.
- When user clicks, drags, and releases the mouse button on the map (essentially mark an area with a rectangle), a pop-up will show up with detailed statistics of each category of hazard that occurred in that particular area. See figure 20 for a potential design of the map viewing interface.

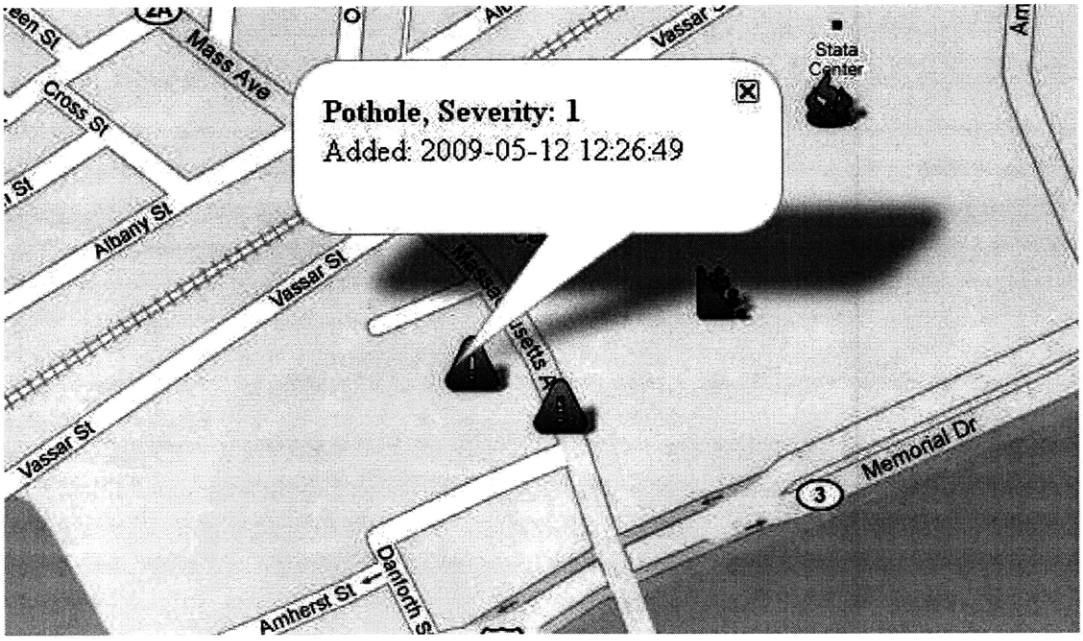


FIGURE 20: MAP VIEWING INTERFACE

PRODUCT DEVELOPMENT PLAN

Iteration Schedule

Hazard Spy project will follow the typical iterative development process. Each iteration is a self-contained development cycle that includes requirement, design, development, and testing. The initial development for a beta product with a J2ME client will typically require 11 weeks, and task breakdown for each iteration is showing in a Gantt Chart (see figure 21)

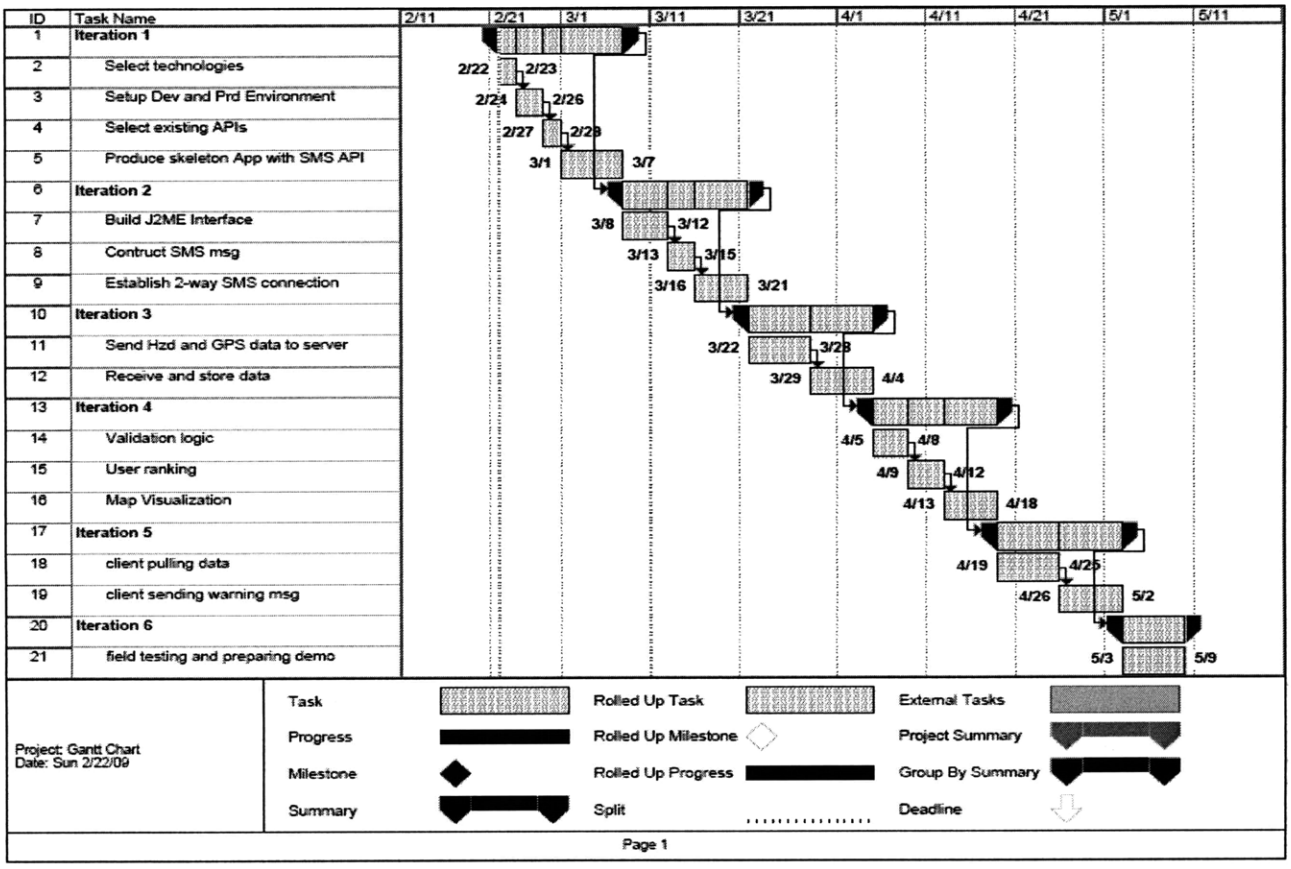


FIGURE 21: PORJECT TIMELINE IN GANTT CHART

Iteration 1:

- Setup development and production environment
- Choose external APIs (either open-source or commercial)
- Produce a skeleton application with HTTP connection API

Iteration 2:

- Build J2ME interface with 3 – 4 hazard choices on handsets
- Construct HTTP message based on user selection
- Establish 2-way HTTP transmissions between handsets and HazardSpy server

Iteration 3:

- Client sends both Hazard selection and GPS data to server
- Server receives data and stores in database

Iteration 4:

- Implement logic for validation with duplication checking
- Put in place a user ranking system
- Plot hazard data on Google Map

Iteration 5:

- Establish a data pulling mechanism on the client
- Transmit data via HTTP from server to the client
- Send warning signals if a hazard is within certain distance of current client location

Iteration 6:

- Production migration and preparing for customer demo

Technical Specs

Client-side

- J2ME-enabled mobile phone that supports text messaging
- GPS-enabled phone or Bluetooth interface with external GPS units
- For more sophisticated devices, accelerometer support

Server side

- PHP and Ruby on Rails supporting hosting provider
- MySQL database functionality to store location coordinates and type of hazard

Visualization

- Google Maps API
- Cross-browser functionality
- AJAX and JavaScript support for real-time updates

Resources needs

For the first two years, Hazard Spy will be developed by 3 developers and one product manager. The product manager will be responsible for gathering requirements and managing the project overall. The developers will come up with a technical design and development. Three developers will cost us $80,000 each annually and the product manager will cost around to $120,000. More developers will be added as the user base grows. Roughly, the goal is to have one developer per million users, and one QA per 10 million users. See the table below for human resource needs from year 1 to year 5.

Title	Annual Salary	Year 1	Year 2	Year 3	Year 4	Year 5
Software Engineers	$80,000	1	2	4	6	7
Quality Assurance	$65,000	1	1	1	1	1
Sales Associate	$100,000	1	2	3	3	3
Sales Manager	$120,000	0	0	1	1	1
Marketing Manager	$90,000	1	1	2	2	2
HR Manager	$70,000	0	1	1	1	1

By utilizing virtual hosting, Hazard Spy will greatly minimize hardware, software, and hosting service costs. Initially, Hazard Spy will need around $500 a month for infrastructure costs, and later will need to scale to up to $2000 a month with a full-scale service provider, such as Amazon's EC2.

RISKS

Intellectual Property risks

Some relevant patents that could cause potential conflicts, or may present themselves as opportunities are:

Utilization of the accelerometer on the phone as a means of collecting road data from the user

1) United States Patent 6768066

This patent is owned by Apple and covers the use of its accelerometer for navigation applications (GPS) in a mobile touch-screen device. This patent was filed in 2006 and is the mainstay of the iPhone's IP.

This patent may force Hazard Spy to have to integrate the use of the accelerometer in a different way for devices that are not the iPhone. Hazard Spy may lay some "landmine" patents since Hazard Spy is a service strictly around detecting and warning road hazards, but not around general navigation.

2) United States Patent 5870687

A vehicle performance analyzer incorporating an acceleration-measuring method and apparatus to use an accelerometer to both measure vehicle performance and assist the user in entering the user-defined parameters or data. This use of an accelerometer to enter data can be widely applied to other electrical devices. The circuit and method uses an accelerometer to cycle discreet user-defined data for selection by the user. This accelerometer-based user interface to enter data is widely applicable to other electrical devices.

Measurement of performance may be extendible to hazard identification and detection of road irregularities. Hazard Spy is build specifically on built-in accelerometer in mobile phones, and plans to file a patent related to that fact.

Transmitting hazard data from a mobile device

3) United States Patent 6768066

This invention relates to an improved system for generating and distributing near real time vehicle crash data, and more particularly, to a system that provides an accident scene record, which is automatically stored and is electronically accessible by authorized parties.

This may limit the potential applications of Hazard Spy. As far as application for road hazards, such as potholes, it appears to have a clear runway with regard to this patent.

Data validation using crowdsourcing and community information

No patents were found that could conflict with this methodology. However, since this is an algorithm, the enforceability of such a patent would be at question. In addition, crowdsourcing

data validation, similar to a wiki, is an existing concept and prior art can be found to defeat patents in this space.

Transmitting data into your phone for selective position-based feed

1) United States Patent 7206585

A method is described for collecting location-dependent data in a central data collection point. The method comprises the steps of: collecting location dependent data from a data source, in a nearby portable communications device; transmitting the collected data to a base station of the portable communications device; and communicating the collected data along with a location identifier to the data collection point.

Hazard Spy intends to collect location data from a cell phone (portable communications device) and transmit it to a centralized base station (may be extended to signify server) along with a location identifier (built-in GPS).

This patent can potentially be a problem for Hazard Spy if the patent holder can prove the above conditions are met. The patent was granted on Apr 17, 2007 to Gilham, Christopher John (Winchester, GB) and Atkinson, Simon John (Romsey, GB). Since this patent does not belong to a large company, one possible way of getting round it is to lay "landmine" patents around the technology that claims a different business process or a different usage scenario. Furthermore, there is always the possibility of negotiating a licensing deal.

2) United States Provisional Patent 60/946,792

Location information is received at a mobile device from the memory of a vehicle device. The mobile device is updated based on the location information. Sensor data is received from at least one sensor measuring movement of the mobile device, and an estimated location of the mobile device is calculated based at least in part on the location information and the sensor data.

If approved, this patent would interfere directly with Hazard Spy's technology. However, because of the wording in the patent it conflicts with the concept of GPS transmission as well, meaning that it may not be enforceable.

Technical risks

Technical risks associated with the product are relatively low. The product depends on existing technologies that are already prevalent in the market today. There is no new development of hardware, or new standards, or protocols. All the phones for which Hazard Spy plans to develop have applications that were developed by other people, so there is an experienced workforce that provide a sizeable hiring pool.

One major technical risk of Hazard Spy is the accuracy of built-in accelerometer in existing phones and the intelligence of the algorithm in differentiating normal road surface imperfections and normal vehicle movements from road hazards. The plan to mitigate the risk is to pilot the application and fine-tune the

algorithm with the City of Boston. A verbal agreement with the Senior Technology Advisor of Boston Mayer's office has been accepted.

MANUFACTURING, SERVICE & LOGISTICS

Product manufacturing

Hazard Spy will be mostly developed in-house in order to ensure high quality and fast response time to market needs. As mentioned above, one developer per million users is needed, plus one QA for every 10 million users. Development tools consist of mainly open-source platforms (such as Linux, CakePhP) and free-wares (such as Eclipse).

Product distribution

Hazard Spy will be distributed through the cloud. No shrink wrap or packaging is involved. There are three ways to distribute: 1) via AppStores (i.e. Apple AppStore, Andriod Store) to reach individual consumers. 2) via Hazard Spy website to reach jail-broken smart-phone owners. 3) Enterprise distribution, which will be hosted in Hazard Spy commercial customer's internal server and distributed via corporate intranet.

Product service

Updates to the software will be pushed via the cloud as well. After software is installed on the phone, updates will be pushed to mobile devices and installed automatically (with user's opt in first). Pushing software updates via the web is a standard practice and it will be this way even when the Hazard Spy user base grows substantially. Hazard Spy will launch a call center to answer customer questions once it reaches a critical mass. Initially, questions will be answered via email, chat, or user community.

FINANCIALS PROJECTIONS

The following set of financial statements outline projections for Hazard Spy over the initial 5 years of operation. This includes Revenue Model, Income statement, Balance Sheet, and Statement of Cash Flows.

Assumptions: Pro Forma Income Statement

The following assumptions were made regarding the pro forma income statement for years 2009-2014:

- Sales forecasts include both Consumer version and Enterprise version of Hazard Spy.
- The consumer version will be available for download by the middle of year 1.
- The Enterprise version will be available for download at the beginning of the second year. Both versions will be free for a 6 month initial promotion period, after which time the full price is charged.
- Unit forecasts assume a 40% conversion rate after the trial period.
- Agreements include Revenue sharing of 30% with Wireless Carrie Application Store distributor.
- Net COGS of 35% (Includes Hardware and Hosting).
- The consumer version is $9.99/ per download. The commercial version is $40 per year.
- Bad debt expenses estimated at 2% of accounts receivable.
- Tax 35% (Includes federal and state taxes)

Assumptions: Pro Forma Cash Flow

The following assumptions were made regarding the cash flow statement:

- Accounts Receivable & Accounts Payable terms = 30 days.
- Bank Loan of $50,000 (Debt Financing) obtained in 4th Quarter of Year 1 to support working capital
- Initial Cash inflow of $125,000 from Founder Seed Capital
- Additional initial Cash inflow of $250,000 from Angel Investors
- 3% annual salary increase for all employees each year
- Salaries paid twice monthly
- Office 70 sq. foot/ employee
- 24k/year travel + expenses for Sales and Marketing personnel

The table below shows Hazard Spy planned headcount:

Title	Annual Salary	Year 1	Year 2	Year 3	Year 4	Year 5
Software Engineers	$80,000	1	2	4	6	7
Quality Assurance	$65,000	1	1	1	1	1
Sales Associate	$100,000	1	2	3	3	3
Sales Manager	$120,000	0	0	1	1	1
Marketing Manager	$90,000	1	1	2	2	2
HR Manager	$70,000	0	1	1	1	1

Risks to Cash Flows

Minimal risk to the above Cash Flows is anticipated as payment from customers is via the application download portal on the wireless carrier website such as AT&T or Blackberry etc.

Financial Summary

- Hazard Spy requires $375,000 upfront investment to launch, and will take 27 months to breakeven.
- Hazard Spy will make $2.7 million in revenue in year 3.
- Hazard Spy will take a $50,000 debt financing in 4th Quarter Year 1.
- Hazard Spy profit margin will max out at 26%.
- Hazard Spy is primarily a B2C product. Sales from Hazard Spy Enterprise version will only be

around 5 – 7 % of total revenue.
- Most of the revenue is from the consumer segment and distributed via the App Store. Therefore, Hazard Spy sales force is relatively small.

See APPENDIX II for detailed Pro Forma statements.

CONCLUSION

The condition of our national and local road infrastructure is deteriorating. Potholes have appeared at an increasing rate on highways and city streets throughout the country. According to Transportation California, potholes and road hazards cause drivers on average $700 a year in vehicle maintenances and repairs, and government $3.5B a year in road repairs and cleanups. Although new financial stimulus packages have approved by the governments to upgrade this aging infrastructure, the amount is not enough for complete coverage of all degraded roads and construction could take years to finish.

One of the possible solutions to reduce financial losses due to road hazards is to utilize the crowd-sourcing concept and to deploy a system that enables citizens to report road hazards more easily. Once a massive amount of hazard data is aggregated, the information can then be used by the government to locate and prioritize hazards early and to do timely repairs.

Currently, to report a road hazard, drivers must either call a hazard hotline or submit a request online. Both of these methods are outdated and flawed. It is very inconvenient for the drivers to report a hazard and the locations are often incorrectly submitted. Consequently, the inaccurate information causes mistrust toward the data, which then causes negligence on the part of the government toward repairing these reported hazards. On the other hand, the real problematic hazards remain unattended, start deteriorating, and can cause more troubles to the drivers in the future. This negative feedback loop will continue unless a solution is put in place that can collect hazard data with accurate location information.

Hazard Spy is a location based citizen reporting system, specifically designed for collecting road hazard data. In most cases, Hazard Spy can use a cell phone's built-in accelerometer to sense abnormal movements of a vehicle during driving, determines the type of the hazard by recognizing the movement against known patterns, and reports a phone's current GPS location to the server automatically. Hazard Spy essentially collects hazard encounters automatically with pin-point location information from the millions of drivers on the road

The technologies needed to make it happen already exist in the market for quite some time. Smartphones have these required technologies built-in. Smartphones have penetrated the U.S. market and their sales has grown in a rapid rate. In addition, Hazard Spy does not require any development of new standards or protocol. As a result, the technology risk of Hazard Spy is low, however, difficult challenges are still foreseeable, particularly on the business execution side. More specifically, Hazard Spy must answer the following three questions.

1) How can citizens be informed about the Hazard Spy system?

   Hazard Spy must investment in viral marketing in order to be successful. The proposed marketing techniques include viral videos, billboard advertising, and advertising among social networking websites.

   In addition, Hazard Spy plans to distribute its client application through various app stores, such as Apple or Andriod App Store. This creates a seamless distribution of Hazard Spy application to smartphone owners and generates needed exposure toward targeted audience.

2) How to make government more responsive to the hazards?

   The existing Pothole Law protects the city from liability for injuries to people who trip or fall on sidewalks that are "out of repair, unsafe, dangerous or obstructed," unless a written notice of the defect has been provided to the city's Department of Transportation at least 15 days before the accident. The same rule applies to drivers and potholes. As a result, the governments hide behind this law and are not diligently repairing potholes

   Hazard Spy plans to sell data subscription services to Law Firms. Hazard Spy will store historical records of all hazard submissions to the appropriate agencies, giving a significant leverage for the lawyers to build a stronger case against local government for excessive negligence.

3) How to become sustainable and be profitable as a service and business?

   Hazard Spy is designed to be profitable from the beginning. The plan is to sell to the application to general consumers first. Among the consumer segment, Hazard Spy will strategically target motorcycle riders, luxury and custom car owners, and parents with small children as the primary target market. As the user base grow and hazard data coverage becomes more comprehensive, Hazard Spy will then sell data subscription to enterprise users. This business model will make Hazard Spy break-even in year 2 and make $2.7 million revenue in year 3.

In conclusion, developing a product to collect hazard data from the citizens with pin-point accuracy may not be a difficult task. After all, the necessary technologies are already exist and been used by people every day. What's more difficult is figuring out how to launch this product into a viable venture that will be used by a large user base and that will bring benefits to the community. Hazard Spy has plans to make this happen.

APPENDIX I – HAZARD SPY SURVEY DETAILS

3. What percentage of your commute is highway vs. city? (please add up to 100)

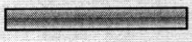
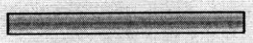
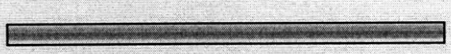
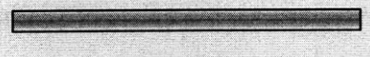
		Response Average	Response Total	Response Count
view	Highway	39.54	3,756	95
view	City	62.44	6,244	100
	answered question			100
	skipped question			0

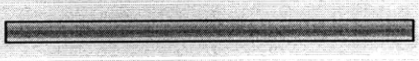
4. Which region do you live in?

		Response Percent	Response Count
Northeast		55.6%	55
Southeast		1.0%	1
Midwest		29.3%	29
Southwest		2.0%	2
Northwest		4.0%	4
West		4.0%	4
Mountains		1.0%	1
Canada		3.0%	3
	answered question		99
	skipped question		1

5. Have you ever had any damages to your vehicle or accidents that are caused by potholes or other road hazards?			
		Response Percent	Response Count
Yes		75.0%	75
No		25.0%	25
	answered question		100
	skipped question		0

6. If answered "Yes" to question 5, check all that apply below.			
		Response Percent	Response Count
Wheels misaligned		61.0%	47
Punctured tire or bent rim		61.0%	47
Damage to suspension or other drivetrain components		41.6%	32
Vehicle underbody damage		26.0%	20
Damages to goods or people inside the car due to violent shakes or side swings		9.1%	7
Collision accident		2.6%	2
I lost control of the car and skidded off-course (non-collision)		10.4%	8
	Other (please specify) view		5
	answered question		77
	skipped question		23

7. What were some of the reasons that you were unable to avoid potholes? (Check all that apply)			
		Response Percent	Response Count
My speed was too fast and I didn't want to make an abrupt, last-second steer		27.4%	26
There were too many distractions (cars, pedestrians, etc) on the road and I didn't see potholes		35.8%	34
I saw the potholes but there were cars next to me so I couldn't change lane		66.3%	63
The road was not illuminated enough during the night so I couldn't see them		52.6%	50
There were too many of them in a stretch it's impossible to dodge all of them		**68.4%**	**65**
My eyesight is focused farther down the road and potholes sneaked up on me		24.2%	23
	Other (please specify) view		3
	answered question		95

8. If you see a pothole or other objects on the road, will you report it?			
		Response Percent	Response Count
No, someone else will do it		10.3%	10
No, I don't know how to do it		**61.9%**	**60**
No, I don't remember the exact location of it		10.3%	10
Yes, I will call in		12.4%	12
Yes, I will submit online		5.2%	5
	answered question		97
	skipped question		3

9. If we build a palm-sized device that you lay it on top of your dashboard and it will warn you about upcoming potholes or other hazards 50 - 100 feet away with 99% accuracy, as well as automatically report to authorities about the location of the potholes if you do run over a pothole, will you use it?			
		Response Percent	Response Count
Yes, only if it's free		45.0%	45
Yes, I am willing to pay up to $20		28.0%	28
Yes, I am willing to pay up to $50		10.0%	10
Yes, but why so inexpensive?		8.0%	8
view No (please specify reasons)		11.0%	11
	answered question		100
	skipped question		0

APPENDIX II: HAZARD SPY FINANCIAL PRO FORMA

Revenue Model

Hazard Spy
Revenue Model

	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
UNIT SALES					
Hazard Spy Consumer	48,886	177,514	497,143	925,714	1,741,144
% Growth		*72%*	*64%*	*46%*	*47%*
Hazard Spy Enterprise	-	3,700	34,500	70,500	106,500
% Growth		*100%*	*89%*	*51%*	*34%*
AVERAGE SALE PER UNIT					
Hazard Spy Consumer	8	15	15	15	15
Hazard Spy Enterprise	-	20	40	40	40
TOTAL SALES (000's)	$733	$2,811	$8,837	$16,706	$30,377

INCOME STATEMENT

Hazard Spy
Income Statement ($ 000's)

Amounts in Thousands (000's)	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
Revenue					
Hazard Spy Consumer	733	2,663	7,457	13,886	26,117
Hazard Spy Enterprise	-	148	1,380	2,820	4,260
Total Revenue	733	2,811	8,837	16,706	30,377
Cost of Goods Sold	244	925	2,831	5,334	9,771
Gross Margin	489	1,886	6,006	11,372	20,606
% of Revenue	*67%*	*67%*	*68%*	*68%*	*68%*
Operating Expenses					
RD	174	281	500	736	877
Sales	150	310	665	687	710
Marketing	118	122	253	262	272
Human Resources	-	87	91	94	98
Advertising & Promotion	192	238	280	323	407
Sales Commissions	-	-	-	-	-
Office, Insurance, Other Expenses	78	287	894	1,682	3,050
Manufacturing	-	-	-	-	-
Total Operating Expenses	712	1,324	2,682	3,784	5,415
% of Revenue	*97%*	*47%*	*30%*	*23%*	*18%*
Income Before Int & Taxes	(223)	562	3,324	7,588	15,192
% of Revenue	*-30%*	*20%*	*38%*	*45%*	*50%*
Interest and Depreciation					
Interest Expense	1	9	7	5	3
Depreciation	-	-	-	-	-
Interest Revenue	2	1	8	35	94
Income Before Taxes	(222)	554	3,325	7,618	15,283
Taxes	$28	$212	$1,164	$2,666	$5,349
Net Income	(250)	342	2,162	4,952	9,934
% of Revenue	*-34%*	*12%*	*24%*	*30%*	*33%*

Hazard Spy

Balance Sheet ($ 000's)

Amounts in Thousands (000's)	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
ASSETS					
Current Assets					
Cash	50	203	1,787	5,857	14,156
Net Accounts Rec	151	440	1,040	1,947	3,644
Inventory	0	0	0	0	0
Total Current Assets	201	643	2,828	7,804	17,800
Gross Fixed Assets	-	2	8	11	12
Less Accum Depreciation	-	-	-	-	-
Net Fixed Assets	-	2	8	11	12
TOTAL ASSETS	201	645	2,836	7,815	17,812
LIABILITIES					
Short Term Liabilities					
Accounts Payable	13	21	29	34	39
Salaries Payable	14	25	48	57	63
Taxes Payable	2	13	39	83	167
Line of Credit	-	-	-	-	-
Current Portion of Capital Equipment Le	-	1	2	1	0
Current Portion of Long Term Debt	10	24	18	12	6
Total Short Term Liabilities	38	83	134	186	275
Long Term Liabilities					
Capital Equipment Lease	-	1	3	2	1
Long Term Debt	38	94	70	46	22
Total Long Term Liabilities	38	95	73	48	23
TOTAL LIABILITIES	76	178	207	235	298
Equity					
Preferred Stock	250	250	250	250	250
Common Stock	125	125	125	125	125
Retained Earnings	(250)	92	2,253	7,205	17,139
Total Equity	125	467	2,628	7,580	17,514
LIABILITIES & EQUITY	201	645	2,836	7,815	17,812

Hazard Spy Pro Forma Income Statement (first year, monthly)

	Month 1 Jul, 2009	Month 2 Aug, 2009	Month 3 Sep, 2009	Month 4 Oct, 2009	Month 5 Nov, 2009	Month 6 Dec, 2009	Month 7 Jan, 2010	Month 8 Feb, 2010	Month 9 Mar, 2010	Month 10 Apr, 2010	Month 11 May, 2010	Month 12 Jun, 2010
Revenue												
Hazard Spy Consumer	0	0	0	0	0	0	75,000	105,000	129,000	127,500	142,500	154,290
Hazard Spy Enterprise	0	0	0	0	0	0	0	0	0	0	0	0
Total Revenue	0	0	0	0	0	0	75,000	105,000	129,000	127,500	142,500	154,290
Expenses												
Cost of Goods Sold												
Unit Cost	0	0	0	0	0	0	25,000	35,000	43,000	42,500	47,500	51,430
Total COGS	0	0	0	0	0	0	25,000	35,000	43,000	42,500	47,500	51,430
Gross Margin	0	0	0	0	0	0	50,000	70,000	86,000	85,000	95,000	102,860
% of Sales	0%	0%	0%	0%	0%	0%	67%	67%	67%	67%	67%	67%
Operating Expenses												
Advertising & Promotion												
Advertising	4,762	4,762	4,762	4,286	4,286	4,286	5,714	5,714	5,714	6,190	6,190	6,190
Trade Shows	0	0	0	10,000	10,000	10,000	0	0	0	20,238	20,238	20,238
Collateral	3,333	3,333	3,333	3,571	3,571	3,571	2,857	2,857	2,857	3,095	3,095	3,095
Total Advertising/Promotion	8,095	8,095	8,095	17,857	17,857	17,857	8,571	8,571	8,571	29,523	29,523	29,523
% of Sales	0%	0%	0%	0%	0%	0%	11%	8%	7%	23%	21%	19%
Office, Insurance, Other Expenses												
Office Rent	280	280	280	280	280	280	490	490	490	490	490	490
Total Office, Insurance, Other	280	280	280	280	280	280	7,990	10,990	13,390	13,240	14,740	15,919
% of Sales	0%	0%	0%	0%	0%	0%	11%	10%	10%	10%	10%	10%
RD												
Headcount	2	2	2	2	2	2	2	2	2	2	2	2
Salary	12,083	12,083	12,083	12,083	12,083	12,083	12,083	12,083	12,083	12,083	12,083	12,083
Benefits & Taxes	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417	2,417
Department Total Expenses	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500	14,500
% of Sales	0%	0%	0%	0%	0%	0%	19%	14%	11%	11%	10%	9%
Sales												
Headcount	1	1	1	1	1	1	1	1	1	1	1	1
Salary	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333	8,333
Benefits & Taxes	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667	1,667
Supplies	300	300	300	300	300	300	300	300	300	300	300	300
Travel & Meals	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
Telephone/Postage	200	200	200	200	200	200	200	200	200	200	200	200
Depreciation	0	0	0	0	0	0	0	0	0	0	0	0

Department Total Expenses	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500	12,500
% of Sales	0%	0%	0%	0%	0%	0%	17%	12%	10%	10%	9%	8%
Marketing												
Headcount	1	1	1	1	1	1	1	1	1	1	1	1
Salary	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
Benefits & Taxes	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500
Office Supplies	100	100	100	100	100	100	100	100	100	100	100	100
Travel & Meals	500	500	500	500	500	500	500	500	500	500	500	500
Telephone/Postage	200	200	200	200	200	200	200	200	200	200	200	200
Depreciation	0	0	0	0	0	0	0	0	0	0	0	0
Department Total Expenses	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800	9,800
% of Sales	0%	0%	0%	0%	0%	0%	13%	9%	8%	8%	7%	6%
Human Resources												
Headcount	0	0	0	0	0	0	0	0	0	0	0	0
Salary	0	0	0	0	0	0	0	0	0	0	0	0
Benefits & Taxes	0	0	0	0	0	0	0	0	0	0	0	0
Department Total Expenses	0	0	0	0	0	0	0	0	0	0	0	0
% of Sales	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total Operating Exp	45,175	45,175	45,175	54,937	54,937	54,937	53,361	56,361	58,761	79,563	81,063	82,242
% of Sales	0%	0%	0%	0%	0%	0%	71%	54%	46%	62%	57%	53%
Income Before Int & Taxes	(45,175)	(45,175)	(45,175)	(54,937)	(54,937)	(54,937)	(3,361)	13,639	27,239	5,437	13,937	20,618
% of Sales	0%	0%	0%	0%	0%	0%	-4%	13%	21%	4%	10%	13%
Interest												
Interest Revenue	313	296	259	221	176	130	84	21	5	1	45	40
Interest Expense (Credit Line)	0	0	0	0	0	0	0	0	0	0	0	0
Interest Expense - (Cap. Equip. Lease)	0	0	0	0	0	0	0	0	0	0	0	0
Interest Expense - (Long Term Debt)	0	0	0	0	0	0	0	0	0	262	258	253
Net Interest Revenue	313	296	259	221	176	130	84	21	5	(261)	(213)	(213)
Income Before Taxes	(44,863)	(44,879)	(44,916)	(54,716)	(54,761)	(54,807)	(3,277)	13,660	27,244	5,176	13,724	20,405
Tax Exp	0	0	0	0	0	0	0	4,781	9,535	1,812	4,803	7,142
Net Income	(44,863)	(44,879)	(44,916)	(54,716)	(54,761)	(54,807)	(3,277)	8,879	17,708	3,364	8,921	13,263
% of Sales	0%	0%	0%	0%	0%	0%	-4%	8%	14%	3%	6%	9%

Hazard Spy Pro Forma Income Statement (year 2 and 3, quarterly)

	Y2Q1	Y2Q2	Y2Q3	Y2Q4	Y3Q1	Y3Q2	Y3Q3	Y3Q4
Revenue								
Hazard Spy Consumer	417,855	430,710	817,500	996,645	1,500,000	1,714,290	2,014,290	2,228,565
Hazard Spy Enterprise	0	0	36,000	112,000	210,000	300,000	390,000	480,000
Total Revenue	417,855	430,710	853,500	1,108,645	1,710,000	2,014,290	2,404,290	2,708,565
	0	0	0	0	0	0	0	0
Expenses	0	0	0	0	0	0	0	0
Cost of Goods Sold	0	0	0	0	0	0	0	0
Unit Cost	139,285	143,570	281,500	360,215	552,500	646,430	768,930	862,855
Total COGS	139,285	143,570	281,500	360,215	552,500	646,430	768,930	862,855
	0	0	0	0	0	0	0	0
Gross Margin	278,570	287,140	572,000	748,430	1,157,500	1,367,860	1,635,360	1,845,710
% of Sales	67%	67%	67%	68%	68%	68%	68%	68%
Operating Expenses								
Advertising & Promotion								
Advertising	21,429	22,857	25,713	32,856	34,287	34,287	35,715	37,143
Trade Shows	0	30,714	0	60,714	0	30,000	0	58,572
Collateral	9,999	13,572	8,571	11,430	12,144	12,144	12,144	13,572
Total Advertising/Promotion	31,428	67,143	34,284	105,000	46,431	76,431	47,859	109,287
% of Sales	8%	16%	4%	9%	3%	4%	2%	4%
Office, Insurance, Other Expenses								
Office Rent	1,470	1,470	1,470	1,470	2,520	2,520	2,520	2,520
Total Office, Insurance, Other	43,256	44,541	86,820	112,335	173,520	203,949	242,949	273,377
% of Sales	10%	10%	10%	10%	10%	10%	10%	10%
RD								
Headcount	3	3	3	3	5	5	5	5
Salary	58,500	58,500	58,500	58,500	104,104	104,104	104,104	104,104
Benefits & Taxes	11,700	11,700	11,700	11,700	20,821	20,821	20,821	20,821
Department Total Expenses	70,200	70,200	70,200	70,200	124,925	124,925	124,925	124,925
% of Sales	17%	16%	8%	6%	7%	6%	5%	5%
Sales								
Headcount	2	2	2	2	4	4	4	4
Salary	52,000	52,000	52,000	52,000	113,568	113,568	113,568	113,568
Benefits & Taxes	10,400	10,400	10,400	10,400	22,714	22,714	22,714	22,714
Supplies	1,800	1,800	1,800	1,800	3,600	3,600	3,600	3,600
Travel & Meals	12,000	12,000	12,000	12,000	24,000	24,000	24,000	24,000
Telephone/Postage	1,200	1,200	1,200	1,200	2,400	2,400	2,400	2,400
Depreciation	0	0	0	0	0	0	0	0

Department Total Expenses	77,400	77,400	77,400	77,400	166,282	166,282	166,282	166,282
% of Sales	19%	18%	9%	7%	10%	8%	7%	6%
Marketing								
Headcount	1	1	1	1	2	2	2	2
Salary	23,400	23,400	23,400	23,400	48,672	48,672	48,672	48,672
Benefits & Taxes	4,680	4,680	4,680	4,680	9,734	9,734	9,734	9,734
Office Supplies	300	300	300	300	600	600	600	600
Travel & Meals	1,500	1,500	1,500	1,500	3,000	3,000	3,000	3,000
Telephone/Postage	600	600	600	600	1,200	1,200	1,200	1,200
Depreciation	0	0	0	0	0	0	0	0
Department Total Expenses	30,480	30,480	30,480	30,480	63,206	63,206	63,206	63,206
% of Sales	7%	7%	4%	3%	4%	3%	3%	2%
Human Resources								
Headcount	1	1	1	1	1	1	1	1
Salary	18,200	18,200	18,200	18,200	18,928	18,928	18,928	18,928
Benefits & Taxes	3,640	3,640	3,640	3,640	3,786	3,786	3,786	3,786
Department Total Expenses	21,840	21,840	21,840	21,840	22,714	22,714	22,714	22,714
% of Sales	5%	5%	3%	2%	1%	1%	1%	1%
Total Operating Exp	274,604	311,604	321,024	417,255	597,077	657,506	667,934	759,790
% of Sales	66%	72%	38%	38%	35%	33%	28%	28%
Income Before Int & Taxes	3,967	(24,464)	250,976	331,176	560,423	710,354	967,426	1,085,920
% of Sales	1%	-6%	29%	30%	33%	35%	40%	40%
Interest								
Interest Revenue	335	365	210	391	690	1,348	2,338	3,687
Interest Expense (Credit Line)	0	0	0	0	0	0	0	0
Interest Expense - (Cap. Equip. Lease)	29	26	24	21	89	80	72	63
Interest Expense - (Long Term Debt)	2,280	2,160	2,040	1,920	1,800	1,680	1,560	1,440
Net Interest Revenue	(1,974)	(1,821)	(1,854)	(1,551)	(1,199)	(412)	706	2,184
	0	0	0	0	0	0	0	0
Income Before Taxes	1,993	(26,285)	249,122	329,625	559,224	709,941	968,132	1,088,104
Tax Exp	5,774	4,161	87,193	115,369	195,728	248,479	338,846	380,836
	0	0	0	0	0	0	0	0
Net Income	(3,781)	(30,446)	161,929	214,256	363,495	461,462	629,286	707,268
% of Sales	-1%	-7%	19%	19%	21%	23%	26%	26%

Balance Sheet		Existing	12/31/2009	12/31/2010	12/31/2011	12/31/2012
ASSETS						
Current Assets						
	Cash	375,000	101,189	49,528	203,286	1,787,478
	Gross Accounts Receivable		0	154,290	448,655	1,061,435
	Allow for Doubtful Accts (Bad Debt)		0	3,086	8,973	21,229
	Net Accounts Rec		0	151,204	439,682	1,040,206
	Inventory		0	5	15	15
Total Current Assets			101,189	200,737	642,983	2,827,699
Gross Fixed Assets						
	Computer Hardware		0	0	2,000	7,000
	Computer Software		0	0	300	900
Total Gross Fixed Assets			0	0	2,300	7,900
Net Fixed Assets			0	0	2,300	7,900
TOTAL ASSETS		**375,000**	**101,189**	**200,737**	**645,283**	**2,835,599**
LIABILITIES			0	7,142	54,535	158,763
Short Term Liabilities						
			11,172	12,600	20,577	28,520
	Accounts Payable		11,172	12,600	20,577	28,520
	Salaries Payable		13,958	13,958	25,350	47,545
	Taxes Payable		0	1,761	13,447	39,147
	Current Portion of Capital Equipment Lease		0	0	511	1,500
	Current Portion of Long Term Debt		0	9,500	23,500	17,500
Total ST Liabs		0	25,130	37,819	83,385	134,212
Long Term Liabilities						
	Capital Equipment Lease		0	0	1,022	3,000
	Long Term Debt		0	38,000	94,000	70,000
Total LT Liabs		0	0	38,000	95,022	73,000
TOTAL LIABILITIES		**0**	**25,130**	**75,819**	**178,407**	**207,212**
Equity						
	Preferred Stock	250,000	250,000	250,000	250,000	250,000
	Common Stock	125,000	125,000	125,000	125,000	125,000
	Retained Earnings	0	(298,941)	(250,083)	91,876	2,253,386
Total Equity		375,000	76,059	124,917	466,876	2,628,386
LIABILITIES & EQUITY		**375,000**	**101,189**	**200,737**	**645,283**	**2,835,599**

Hazard Spy

Statement of Cash Flows ($ 000's)

Amounts in Thousands (000's)	FY 2010	FY 2011	FY 2012	FY 2013	FY 2014
BEGINNING CASH	375	50	203	1,787	5,857
Sources of Cash					
Net Income	(250)	342	2,162	4,952	9,934
Add Depr/Amort	-	-	-	-	-
Issuance of Preferred Stock	-	-	-	-	-
Issuance of Common Stock	-	-	-	-	-
Plus Changes In:					
Accounts Payable	13	8	8	5	5
Salaries Payable	14	11	22	9	6
Taxes Payable	2	12	26	44	84
Additions to Line of Credit	-	-	-	-	-
Additions to Capital Equipment Lease	-	2	5	2	1
Additions to Long Term Debt	49	98	-	-	-
Total Sources of Cash	(173)	473	2,223	5,012	10,031
Uses of Cash					
Less Changes In:					
Net Accounts Rec	151	288	601	907	1,697
Inventory	0	0	-	-	-
Gross Fixed Assets	-	2	6	3	1
Reductions To Credit Line	-	-	-	-	-
Reductions To Capital Equipment Lease	-	1	2	3	4
Reductions To Long Term Debt	2	28	30	30	30
Stock Buyback	-	-	-	-	-
Total Uses	153	319	639	943	1,732
CHANGES IN CASH	(325)	154	1,584	4,069	8,299
ENDING CASH	50	203	1,787	5,857	14,156

MONTHLY CASH FLOWS

Cash Flow Statement		7/31/2009	8/31/2009	9/30/2009	10/31/2009	11/30/2009	12/31/2009	1/31/2010	2/28/2010	3/31/2010	4/30/2010	5/31/2010	6/30/2010
BEGINNING CASH		375,000	355,506	310,627	265,711	210,757	155,996	101,189	25,126	5,779	1,140	53,950	48,075
Sources of Cash													
	Net Income	(44,863)	(44,879)	(44,916)	(54,716)	(54,761)	(54,807)	(3,277)	8,879	17,708	3,364	8,921	13,263
Plus Changes In:													
	Accounts Payable	11,410	0	0	(238)	0	0	719	(5)	0	714	0	0
	Salaries Payable	13,958	0	0	0	0	0	0	0	0	0	0	0
	Taxes Payable	0	0	0	0	0	0	0	1,179	1,172	(1,905)	738	577
	Additions to Line of Credit	0	0	0	0	0	0	0	0	0	0	0	0
	Additions to Capital Equipment	0	0	0	0	0	0	0	0	0	0	0	0
	Additions to Long Term Debt	0	0	0	0	0	0	0	0	0	49,167	0	0
Total Sources of Cash		**(19,494)**	**(44,879)**	**(44,916)**	**(54,954)**	**(54,761)**	**(54,807)**	**(2,558)**	**10,053**	**18,881**	**51,340**	**9,658**	**13,840**
Uses of Cash													
	Buyback of Preferred Stock	0	0	0	0	0	0	0	0	0	0	0	0
	Buyback of Common Stock	0	0	0	0	0	0	0	0	0	0	0	0
Less Changes In:													
	Net Accounts Rec	0	0	0	0	0	0	73,500	29,400	23,520	(1,470)	14,700	11,554
	Reductions To Capital Equipme	0	0	0	0	0	0	0	0	0	0	0	0
	Reductions To Long Term Deb	0	0	0	0	0	0	0	0	0	0	833	833
Total Uses of Cash		**0**	**0**	**0**	**0**	**0**	**0**	**73,505**	**29,400**	**23,520**	**(1,470)**	**15,533**	**12,388**
CHANGES IN CASH		**(19,494)**	**(44,879)**	**(44,916)**	**(54,954)**	**(54,761)**	**(54,807)**	**(76,063)**	**(19,347)**	**(4,639)**	**52,810**	**(5,875)**	**1,452**
ENDING CASH		**355,506**	**310,627**	**265,711**	**210,757**	**155,996**	**101,189**	**25,126**	**5,779**	**1,140**	**53,950**	**48,075**	**49,528**

CASH FLOW CONTINUED:

Cash Flow Statement		12/31/2010	3/31/2011	6/30/2011	9/30/2011	12/31/2011	3/31/2012	6/30/2012
BEGINNING CASH		138,098	98,874	208,446	358,052	684,991	1,132,596	1,712,088
Sources of Cash								
	Net Income	7,728	74,945	101,280	162,277	200,227	263,563	294,846
Plus Changes In:								
	Accounts Payable	0	0	0	0	0	0	0
	Salaries Payable	0	0	0	0	0	0	0
	Taxes Payable	1,026	4,008	5,551	7,904	8,954	10,425	11,476
	Additions to Line of Credit	0	0	0	0	0	0	0
	Additions to Capital Equipment	0	0	0	0	0	0	0
	Additions to Long Term Debt	0	0	0	0	0	0	0
Total Sources of Cash		**8,754**	**78,953**	**106,831**	**170,181**	**209,181**	**273,988**	**306,321**
Uses of Cash								
	Buyback of Preferred Stock	0	0	0	0	0	0	0
	Buyback of Common Stock	0	0	0	0	0	0	0
Less Changes In:								
	Net Accounts Rec	53,552	79,380	109,427	156,800	177,792	207,192	228,213
	Reductions To Capital Equipme	64	64	64	219	219	219	219
	Reductions To Long Term Deb	2,500	2,500	2,500	2,500	2,500	2,500	2,500
Total Uses of Cash		**56,116**	**81,944**	**111,991**	**159,519**	**180,511**	**209,911**	**230,932**
CHANGES IN CASH		**(47,362)**	**(2,991)**	**(5,160)**	**10,662**	**28,670**	**64,077**	**75,389**
ENDING CASH		**90,736**	**95,883**	**203,286**	**368,714**	**713,661**	**1,196,673**	**1,787,478**

Break Even Point

To pay back the original investment of $375,000, it will take 27 months (two years and three months).